Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

PREPACKAGING LETTUCE at shipping point

U. S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
JUL 20 1964
CURRENT SERIAL RECORDS

MARKETING RESEARCH REPORT NO. 670

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
TRANSPORTATION AND FACILITIES RESEARCH DIVISION

PREFACE AND ACKNOWLEDGMENT

This report is one of a number evaluating new packages and shipping containers and new methods of packing agricultural products. The study on which this report is based is part of a broad program of research aimed at improving marketing efficiency and expanding markets for farm products.

Prepackaging lettuce in the production area promises to be a means of supplying better lettuce to the consumer at a lower marketing cost. Although the methods of prepackaging lettuce with shrink films at point of production are still in the early stages of development, this report was written in response to the many inquiries for information that have been received by the Department.

Many people contributed to the study:

Jack E. Bias of the Grower-Shipper Vegetable Association of Central California provided valuable counsel.

Bruce Church, Inc.; Bud Antle, Inc.; Harden Farms; K. R. Nutting Company; Salinas Marketing Cooperative; Salinas Valley Vegetable Exchange; Sunrise Packing Company; Earl C. Recker Company; and Garwood Johns, Inc., made their harvesting and packing operations available for study.

Dobeckmun Division of Dow Chemical Co., Plax Corporation, Reynolds Metal Company, Goodyear Rubber and Tire Company, Union Carbide Company, and the W. R. Grace Company supplied materials.

Dr. Paul Bessey, University of Arizona, Mesa, Ariz., and William R. Barger, Market Quality Research Division, Agricultural Marketing Service, Fresno, Calif., gave technical advice and assistance.

Dr. B. A. Friedman and M. J. Ceponis conducted a holding test in the laboratory of the Market Quality Research Division in New York City.

Related publications previously issued by the U. S. Department of Agriculture include:

✓ Prepackaging Alabama and Florida Potatoes at Production Points, Marketing Research Report 572, January 1963.

Evaluation of Selected Consumer Packages and Shipping Containers for Peaches, Marketing Research Report 533, June 1962.

Lettuce Prepackaged at Shipping Point--A Preliminary Market Survey, AMS-481, June 1962.

Prepackaging Medium-Size Apples in Shrinkable Films at Shipping Point, Marketing Research Report 534, April 1962.

Evaluation of Shipping Trays and Pads for Pears and Apples, Marketing Research Report 530, April 1962.

Field Trimming of Lettuce - Effects on Package Weight and Market Quality, Marketing Research Report 497, September 1961.

Evaluation of Shipping Containers for Washington Cherries, Marketing Research Report 426, September 1960.

Packaging California Cauliflower, Marketing Research Report 414, July 1960.

Prepackaging California Grapes at Shipping Point, Marketing Research Report 410, July 1960.

*Prepackaging Early California Potatoes at Point of Production, Marketing Research Report 401, June 1960.

Prepackaging Firm Ripe Peaches, AMS-312, June 1959.

Evaluation of Shipping Containers for Western Lettuce, Marketing Research Report 248, July 1958.

**Packing California Potatoes in Fiberboard Boxes, Marketing Research Report 214, February 1958. (20 cents)

**Development of Carrot Prepackaging, Marketing Research Report 185, June 1957. (25 cents)

New Shipping Containers for Plums, Marketing Research Report 128, June 1956.

---

*Out of print. May be consulted in public libraries maintaining Government publications.

**Available from Superintendent of Documents, Government Printing Office, Washington, D. C., 20402, at price indicated.

July 1964

CONTENTS

Page

Summary.......... 4
Introduction.......... 5
  Background.......... 5
  Problem.......... 7
  Procedure.......... 8
  Definition of terms.......... 8
Packaging materials.......... 8
  Unwrapped pack.......... 8
  Wrapped pack.......... 9
  Comparative costs.......... 12
How lettuce is packed.......... 12
  Unwrapped.......... 12
  Wrapped.......... 14
Direct labor requirements and costs.......... 24
  Unwrapped.......... 25
  Wrapped.......... 25
Combined costs of packaging materials and direct labor.......... 28
Transportation costs.......... 29
Vacuum cooling wrapped lettuce.......... 30
Condition of lettuce at terminal.......... 32
  Condition on arrival.......... 33
  Condition after holding.......... 34
  Discussion.......... 36
Trade reaction.......... 36
Consumer reaction.......... 37
Advantages.......... 41
Disadvantages.......... 42
Unsolved problems.......... 42
Appendix.......... 44

SUMMARY

Lettuce was prepackaged successfully in California and Arizona for shipment to eastern markets where it usually arrived in as good condition as unwrapped lettuce. Often its condition was better. Wrapped lettuce had a longer display life than unwrapped lettuce, but minor defects assumed greater importance.

The uncertainty of dependable supplies of high quality heads is the principal factor deterring the prepackaging of lettuce at shipping point. Lettuce of inferior quality cannot be prepackaged at source with assurance that it will reach the retail display with appearance acceptable to consumers. However, it can be trimmed and prepackaged in the store.

When lettuce is prepackaged at shipping point, about one-third of the weight of the lettuce shipped is eliminated by removal of the wrapper leaves. For this reason it costs about 30 cents less per box of 24 heads to ship wrapped lettuce from Salinas, Calif., to New York City.

Material and labor costs to prepackage lettuce at shipping point were 30 to 43 cents higher per box than to pack unwrapped lettuce. Higher development, overhead and capital expenses pushed the additional unit cost to about 50 cents--the premium usually charged for prepackaged lettuce. The cost of prepackaging lettuce at shipping point does not add to the total cost of marketing lettuce because the costs of performing these operations is merely shifted from the retailer to the shipper. Therefore, the chief net advantage in prepackaging lettuce at shipping point is the saving in transportation costs which could amount to several million dollars annually.

Six types of film were evaluated: Polystyrene, cast polyvinyl chloride, irradiated polyethylene, polypropylene--all shrinkable--extruded polyvinyl chloride, which stretches, and nonshrinkable polyethylene. Prepackaged lettuce was examined in eastern markets after experimental shipment across the country and subsequent holding for 1 to 5 days at temperatures ranging from a favorable 40 degrees to an unfavorable 70 degrees. Under ideal crop and marketing conditions there was no conclusive evidence that one film was better than another in prolonging shelf life. When lettuce of poor quality was wrapped, or when it was marketed under unfavorable temperature conditions, the lettuce packed in the less permeable films usually deteriorated more quickly than lettuce wrapped in more permeable films that did not trap excessive amounts of moisture.

The prepackaged lettuce was vacuum cooled in a commercially acceptable period of time if the film was perforated or small openings were provided in inperfect seals to permit rapid passage of water vapor through the wrap, as in polystyrene.

Store produce managers liked prepackaged lettuce, they said, because it saved time in trimming the heads, disposing of the waste, and building and maintaining displays. Shoppers, accustomed to soft films, were critical of the brittle feel of the polystyrene in which most of the lettuce was wrapped.

PREPACKAGING LETTUCE at shipping point

Peter G. Chapogas and Donald R. Stokes, agricultural marketing specialists
Transportation and Facilities Research Division
Agricultural Marketing Service

INTRODUCTION

In December 1959, the U. S. Department of Agriculture packaging research staff began exploring the possibilities of wrapping lettuce in shrink films. The first cross-country test shipment was initiated in August 1960 and more tests followed.

The results were so promising that several Salinas, Calif., shippers began sending small lots of prepackaged lettuce to customers throughout the country. Through the summer and fall of 1961, interest increased and many shippers began prepackaging lettuce or made preparations to wrap it. Very rapid development of equipment and techniques followed. During parts of January and February 1962, prepackaged lettuce shipments varied between 5 and 10 percent of total daily shipments--20 to 40 cars per day. Cold weather during the late winter caused widespread frost damage which set back and slowed down the rapid expansion. However, more than 6,000 cars of prepackaged lettuce went to market from western producing areas in 1962.

Prepackaging lettuce at shipping point is still in an early stage of development. Shippers and research agencies continue their experiments, and changes in technique and equipment are being made almost daily. This report was written in response to the many requests to the Department for information.

Background

Since the early 1930's, researchers have proven repeatedly the benefits of preventing moisture loss from leafy green vegetables. Moisture barriers studied have included parchment paper, cellophane, rubber hydrochloride, and other plastic films. Tests indicated that when these films reduced moisture loss and at the same time allowed passage of gases, they extended the shelf life of green vegetables if adequate refrigeration was maintained. In store packaging operations, retailers found that the films not only kept the lettuce fresher, but that they also reduced damage from repeated handlings by shoppers.

The development of a method to prepackage lettuce at shipping point has been in progress for more than 30 years. In 1931, a commercial shipper experimented with wrapping head lettuce in cellophane.

In the early 1940's, U. S. Department of Agriculture packaging personnel worked with an eastern supermarket chain on the development of an operation to package lettuce at the warehouse. 1/ The lettuce was placed in trays and automatically wrapped with cellophane. The chain stores discontinued the operation after a few years because they found it too expensive.

In the middle 1940's, a group of California shippers set up a central packaging plant in Los Angeles. Lettuce was shipped to this plant from production areas to be processed, packaged, and shipped to market. This enterprise did not succeed because of the irregularity of the lettuce supply and because the growers were unable to recapture the extra cost of packaging.

After World War II, produce packaging began to develop at a faster pace. The availability of better packaging films and improved techniques and the growth of the supermarket system of distribution added impetus.

In the late 1940's another supermarket chain set up an operation in the Midwest in an attempt to prepackage lettuce en route to destination. The costs of trimming, packaging, and repacking in a shipping container proved to be excessive.

In the early 1950's the U. S. Department of Agriculture, in cooperation with the United Fresh Fruit and Vegetable Association, worked with a group of wholesalers who supplied retailers with cellophane bags. 2/ Various aids were developed for in-store packaging. Studies were made of waste and spoilage loss and sales of packaged and nonpackaged lettuce. Consumers readily accepted the packaged lettuce and the bag reduced losses and wilting, but it was still quite expensive. The project encouraged the packaging of lettuce in retail stores and later, when low-cost polyethylene bags were introduced, the practice of retailing prepackaged lettuce became widely established.

In the meantime, interest in prepackaging lettuce at shipping point arose again. In the early 1950's, several shippers experimented with cellophane and one shipper has continued this development work to the present time.

In cooperation with the Western Growers Association, Department researchers evaluated more than a dozen types of transparent films for prepackaging vegetables. Simulated transcontinental shipments of the packaged vegetables were made.

The military agencies began buying lettuce in film bags following research by the U. S. Department of Agriculture showing that the life of packaged lettuce was extended during long storage periods encountered on ships and in transit to distant posts. 3/ Decayed heads were isolated so that

---

1/ Stokes, Donald R., "Retailing Prepackaged Fresh Produce by Self-Service Food Stores" Marketing and Transportation Situation, April-May 1948.

2/ Hawes, Russel L., and Stokes, Donald R., "Prepackaged Lettuce is Preferred, But..." U.S. Dept. Agr., Mktg. Activities, Feb-March 1954.

3/ Parsons, C. S. "Extending the Storage Life of Cabbage, Celery, Lettuce, and Tomatoes Aboard a Navy Supply Ship" U. S. Dept. Agr. Mkt. Res. Rpt. 336, 15pp. 1959.

decay could not spread to adjacent heads, and wilting was prevented. Since the Korean War these agencies have been buying lettuce prepackaged in polyethylene bags on a more or less regular basis. This procedure has been generally satisfactory under good refrigeration.

The current development program began in the winter of 1959-60 when U. S. Department of Agriculture personnel experimented with lettuce wrapped in irradiated, shrinkable polyethylene at the terminal market. Again, costs proved to be too high, but the packaging research personnel were very much impressed by the good appearance, retail shelf protection, and the ease of manual wrapping afforded by the shrink film. During the ensuing months, additional information was gathered and more experience was obtained in the use of shrink films. In the summer of 1960, a test shipment program for lettuce prepackaged at source was begun.

By the spring of 1961, so much trade interest had been aroused that several shippers began planning commercial wrapping of lettuce. Considerable assistance was given to packers in the development of pilot packaging lines to prepare trial shipments to their customers.

Problem

Mechanical Damage

Conventionally packed lettuce is usually shipped with 4 to 6 wrapper leaves left on the heads. The wrapper leaves provide some protection against head-leaf bruising and moisture loss, but they also provide possible sources of contamination. These leaves comprise 20 to 35 percent of the weight of the packed box. A trend to larger heads has resulted in 50 or more pounds of lettuce frequently being packed in boxes that were originally designed to contain 37 to 43 pounds. When this heavy lettuce is packed, the heads must be rolled or jammed into the box, with resultant injury to the leaves. Furthermore, when the retailer prepares the lettuce for retail display, he must trim the heads, discarding wrapper leaves and those head leaves that are discolored, bruised, or broken.

High Distribution Costs

The inclusion of wrapper leaves in the bulk pack results in high costs at two places in the marketing channels. First, the extra weight of the lettuce in shipment--about 10,000 pounds per carload--adds to transportation costs. A second factor is the cost of labor involved in handling and trimming the heads at retail level. Depending on wage rates, labor productivity, and lettuce quality, this cost ranges from 20 to 30 cents per box. Additional costs must be incurred to handle and dispose of the waste. Then, if retailers package the lettuce after they trim it (as is done in many areas of the country), 20 to 25 cents per box is added for packaging materials and labor. Thus, the total cost of handling, trimming and packaging lettuce in the retail store ranges between 40 and 55 cents per box.

At the outset, therefore, the researchers reasoned that prepackaging lettuce at shipping point could extend shelf life, reduce transportation costs, and reduce the costs of handling and preparing the lettuce in the retail stores, if effective packaging materials and economical packaging methods could be developed.

Procedure

The research staff cooperated closely with growers and shippers, manufacturers of packaging materials, wholesale and supermarket chain buyers, and retailers.

Methods of manually wrapping heads of lettuce in various types of films were developed. Experiments were also conducted with various shrinking methods and shrinking temperatures. Trimming methods were studied and criteria for satisfactory trimming were developed. The effect of various types of wraps and plastic films on the rate of vacuum cooling was determined.

The costs of bulk-packing unwrapped lettuce and prepackaging were compared. Alternative methods of prepackaging were studied and analyzed.

Nineteen rail and truck shipments of controlled lots of lettuce were initiated on the west coast and examined in eastern markets. The trade reaction to the experimental packages was studied.

Definition of Terms

The lettuce package, with few exceptions, consisted simply of a transparent film sheet wrapped around the head, sealed, and shrunk snugly over the surface of the leaves. Hence, prepackaged heads often are called wrapped lettuce. In contrast, heads marketed in the conventional pack, and not prepackaged, are termed nonwrapped or unpackaged lettuce.

PACKAGING MATERIALS

Unwrapped Pack

Practically all western lettuce is packed in a one-piece regular slotted container (Freight Container Tariff No. 7306) usually constructed of at least 300-pound Mullen test, double-faced, corrugated fiberboard. Inside dimensions are 9-3/4 by 14 by 21 inches and the capacity is 2,876 cubic inches. Two 1/4 by 2-inch ventilation slots are die cut in each side panel.

The standard lettuce box--often called a carton--costs 25 cents, but the price to individual growers can vary 2 or 3 cents depending on printing, design variations, and purchasing methods.

The boxes are usually assembled on a post stitcher, and 16 staples fasten the bottom flaps. A hand stapler closes the top flaps with 8 staples. The average cost of the staples is 1 cent a box.

Some shippers use boxes with flaps having a coating of pressure sensitive glue, which costs an additional 1.6 cents a box.

Two types of top pads are used. The so-called shirt-board pad, made of chipboard and costing 0.55 cent each, was used by the shippers observed in this study. The second type is a soft paper pad that costs 1 cent.

Wrapped Pack

Although some shippers experimented with different sizes of shipping containers, most of them used the same standard (7306) box for prepackaged lettuce. Some shippers had the standard carton manufactured with the opening on the narrow size (9-3/4 inches) rather than the wide side (14 inches). Some of the boxes were made with 1-1/2-inch to 1-3/4-inch gaps between flaps on bottom and top. The cost of this container was the same as the one used for the bulk pack.

Although they experimented with other films, 1-mil thick polystyrene was used by practically all the packers who shipped commercially in 1961 and 1962. Thinner gage films, such as 0.86 mil, were used in 1963. It was normally bought in 17-inch wide rolls printed one color. The average price of this polystyrene film was 63 cents per pound unprinted and 87.5 cents per pound printed in one color.

For all practical purposes, a 17- by 17-inch (289 sq. in.) sheet of film was used for almost all the sizes of lettuce. Only the very large heads required an 18- by 18-inch sheet. The average cost of one 17- by 17-inch sheet of 1-mil polystyrene film printed in one color was 1.01 cents per sheet. Included in this cost is an allowance of 5 percent for film waste.

Packaging Films

While thermoplastic films are being manufactured and are still in a hot, semiplastic stage, they can be stretched biaxially, thus greatly reducing their thickness. During this stretching the polymer molecules are lined up or oriented; as the film cools these molecules become fixed in their oriented position. However, when heat is again applied, the film tends to shrink back to its original size. The degree of shrink depends on how much the film was stretched and the type of plastic that was used. The use of this shrink property has already found many applications in the packaging industry, but most research people feel that the development of shrink materials and their application has barely begun.

Several different shrink films were tried for shipping-point packaging of lettuce; the comparative properties of four types are shown in table 1. This is not meant to be a complete listing, because there are many other oriented films on the market or in various stages of development. Also, the manufacturers of the films listed are doing considerable research on the improvement and modification of their films and the development of techniques for application to fresh produce.

Table 1.--Properties, specifications, and costs of four types of films used in lettuce packaging experiments, 1962 1/

Item	Units	Polystyrene (shrinkable)	Irradiated polyethylene (shrinkable)	Cast polyvinyl chloride (shrinkable)	Extruded polyvinyl chloride (stretches)
Gage	Mils	1	1	1/2	3/4
Maximum shrink	Percent	30-60	50-80	62-68	8
Heat sealing temperature	°F.	250-330	300-500	310-335	340-370
Shrink tunnel temperature	°F.	300-330	300-400	285-310	None
Water vapor transmission rate 2/	Gm.	8.2	.65	13.0	18.0
O_2 permeability rate 3/	cc.	210-300	484	100	95
CO_2 permeability rate 3/	cc.	790-930	1,742	450	320
Yield per pound	sq. in.	26,300	30,000	40,000	28,700
Price per pound, unprinted	Dollars	.63	.89	1.305	.665
Price per pound, printed one color	Dollars	.875	1.90	2.00	1.25
Price per 1,000 sq. in., unprinted	Cents	2.40	2.97	3.26	2.32

1/ Based on information supplied by manufacturers. The costs of plain film are on purchases of 10,000 pounds or more. The costs of printed films are estimates, since these prices will vary considerably for individual users.

2/ Gm./100 sq. in./24 hours at 100° F. and 95 to 100 percent relative humidity ($CaCl_2$).

3/ Dry gas transmission. CC/100 sq. in./24 hours at 72°-77° F. and one atmosphere.

Polystyrene--Polystyrene film won early acceptance as a lettuce wrap. It is a low-cost, low-density, shrinkable film with good clarity and high-gloss characteristics. The film is stiff and has a distinctive metalic-like crackling sound when it is crumpled. Its water vapor transmission rate and oxygen and carbon dioxide permeability rates are fairly high. When polystyrene film is used for wrapping lettuce, these permeability rates are higher because (1) the seal is rately completely airtight, and (2) when the film is manipulated and shaped during the wrapping operation, tiny cracks are believed to develop.

The incomplete seal and the tiny cracks are advantageous in vacuum cooling. Although little factual evidence is available on the behavior of shrink films in vacuum chambers, various experiments indicate that rapid vacuum cooling of lettuce wrapped in polystyrene film depends not only on the water vapor transmission rate of the film, but also on the very small air passages found in seal and film failures. The properties of polystyrene film seem to strike a balance that permits the transfer of sufficient water vapor and gases to prevent suboxidation and still protects the lettuce from excessive moisture loss.

Printing this film has not been a problem. Local converters have been able to do a good job at a relatively low cost.

Irradiated Polyethylene--This low-density polyethylene film is oriented and irradiated for shrinkability and increased strength. It is a soft, very strong, clear film that shrinks to 50 to 80 percent of its original size.

When the proper technique is used, the film forms a tight seal. Consequently, it must be perforated or left partially open to permit the escape of water vapor during vacuum cooling. The water vapor transmission rate is relatively low but oxygen and carbon dioxide permeability rates are high.

At present, all printing is done by the film manufacturer.

Cast Oriented Polyvinyl Chloride--This is a clear, bright, and glossy film. It is biaxially oriented and shrinks over 60 percent when heat is applied. It seals easily, forming very tight seals. The water vapor transmission rate and gas permeability rates in table 1 are for only one formulation of this material. By changing the proportion of plasticizer used in the formulation, this film can be manufactured so that it will have different degrees of rigidity and of water vapor, O_2, and CO_2 permeability. It is a soft film with good "cling" (ability of the film to stick to itself) characteristics. Although it has a fairly high water vapor transmission rate, it must be perforated to permit adequate cooling in the vacuum coolers, and to prevent excessive accumulation of moisture within the package.

Local converters can print the film. As yet, the cost of printing is relatively high, but it is expected that costs will be reduced as converters gain experience.

Extruded Polyvinyl Chloride--This clear, soft, low-cost formulation of polyvinyl chloride is not, strictly speaking, a shrink film, although it will shrink 7 to 8 percent. However, instead of shrinking, this film can be stretched around a product to form a tight wrap with no seal, or a very light seal. Many shippers were interested in trying this film because lettuce wrapped in it could, when necessary, be unwrapped and rewrapped without damaging the film.

Like the oriented cast polyvinyl chloride film, this film must be perforated to provide for rapid vacuum cooling and transmission of water vapor and CO_2 gas from within the package. This film has been used for lettuce packaging at the retail level, and in 1963 some western shippers were using it.

Other Films--In addition to these four films observed in the production area, lettuce in nonshrinkable polyethylene bags and in shrinkable polypropylene wraps also was examined in terminal markets.

Comparative Costs

Comparative costs of materials for packing unwrapped and wrapped lettuce per box of 24 heads in 1962 were as follows:

Material	Unwrapped	Wrapped
	Cents	Cents
Box (with staples).....................	26.00	26.00
Top pad................................	.55	---
1-mil polystyrene film.................	---	24.24
Total..................	26.55	50.24

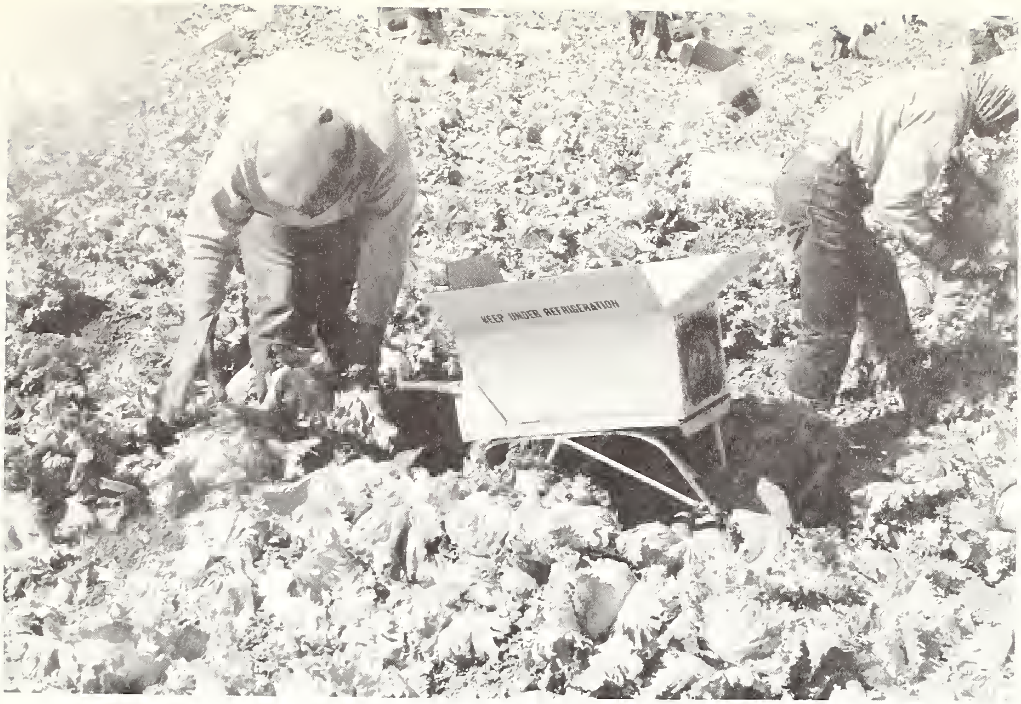
The film cost includes 24 sheets 17 by 17 inches printed in one color and an allowance of 5 percent for waste. Only the cost of polystyrene is listed above because it was the only film used in commercial quantities during 1961 and 1962 when these studies were made.

HOW LETTUCE IS PACKED

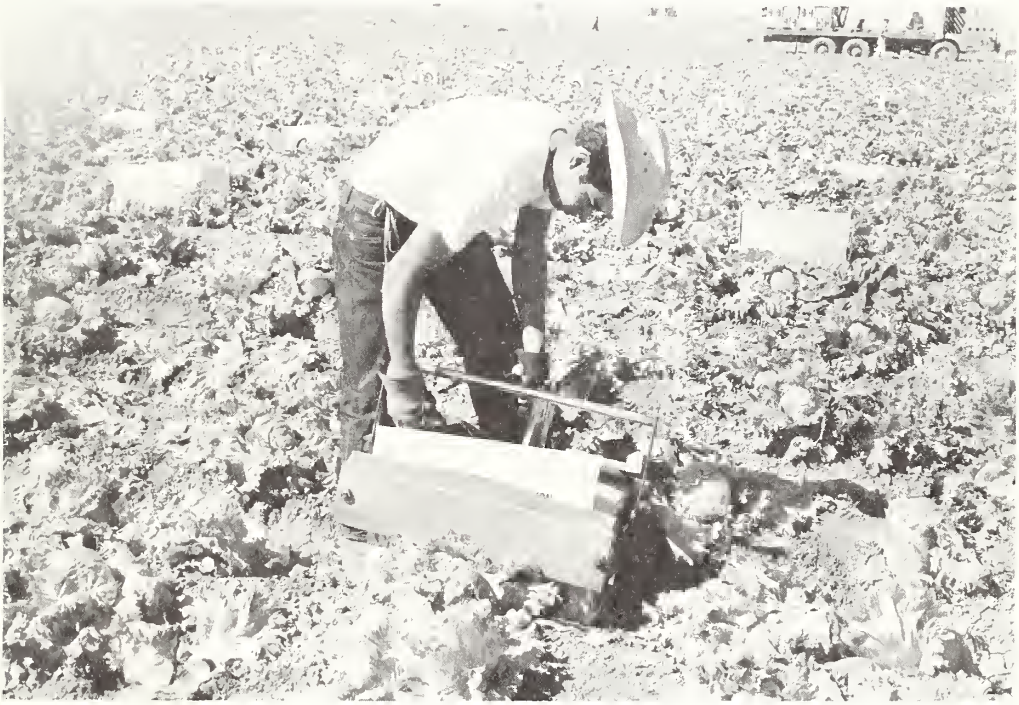
These studies were made in a period during which experimentation and development of the techniques for prepackaging proceeded at a rapid pace. Day-to-day changes occurred. Although many studies were made, sufficient data for this report were accumulated in only four sheds and one field packaging operation. However, even these operations in all probability will change considerably. One conventional field packing operation was studied for comparison.

Unwrapped

The fiberboard master containers were transported to the fields folded flat on large trucks equipped with a post stitcher, used to staple the bottom flaps of the box. The packing crews consisted of cutters who sliced through the lettuce stalk, removed any damaged leaves, and laid the head back on the ground; packers who followed the cutters with portable, single-wheel, packing stands; and box closers who followed the packers with a steel clamp device that squared up the box and held down the top flaps to permit securing them with a hand stapler, (fig. 1). Also, usually two workers, called head carry men, consolidated the heads so the packers did not have to travel far to fill a box; two workers distributed empty boxes to the packers; and two workers,



BN-44348



BN-44352

Figure 1.--Worker at top packs untrimmed lettuce in box resting on portable stand which resembles a small wheelbarrow. Worker below squares up bulging box with metal clamp, preparatory to closing by stapling flaps.

called wash and pad men, carried tanks of water on their backs to rinse the exposed butts of the top-layer heads, and placed pads over the top-layer butts.

The lettuce was usually packed 24 heads to the box, but when the heads were unusually large or unusually small, it was packed 18 to 30 heads to the box.

The 12 heads in the bottom layer were packed butts down and the 12 top layer heads were packed butts up. The heads with 4 to 6 wrapper leaves fit very tightly in the box so that the packers had to bridge the last 6 heads in each layer and force them into place with a rolling motion.

After the boxes were packed, workers loaded them on pallets in trucks which transported them to the vacuum coolers.

Wrapped

Since lettuce was first commercially wrapped in shrink film in the spring of 1961, three types of packaging operations have developed in the industry. Some shippers packaged in centrally located sheds; other packaged in the field in large mobile packaging plants that carried the wrappers and packers; and one shipper was trying out a portable packing shed which would represent a compromise between the centrally located shed and the field-pack operation.

When the centrally located or the portable shed was used, the lettuce was cut in the fields, then hauled to the packing shed where it was trimmed, wrapped, and packed into shipping containers, and then vacuum cooled.

When the field operation was used, the cutters who harvested the lettuce also trimmed the heads. The heads then were picked up by other workers and placed on mobile packaging plants where they were wrapped and packed in shipping containers. The packed shipping containers were transported to vacuum coolers.

The portable field shed was similar in operation to the centrally located sheds, except that it was set up on the ranch. It could be moved on trucks from one production area to another, allowing the packer who had several lettuce deals during the year greater flexibility at a lower capital outlay. The first of these sheds was set up shortly before this report was written.

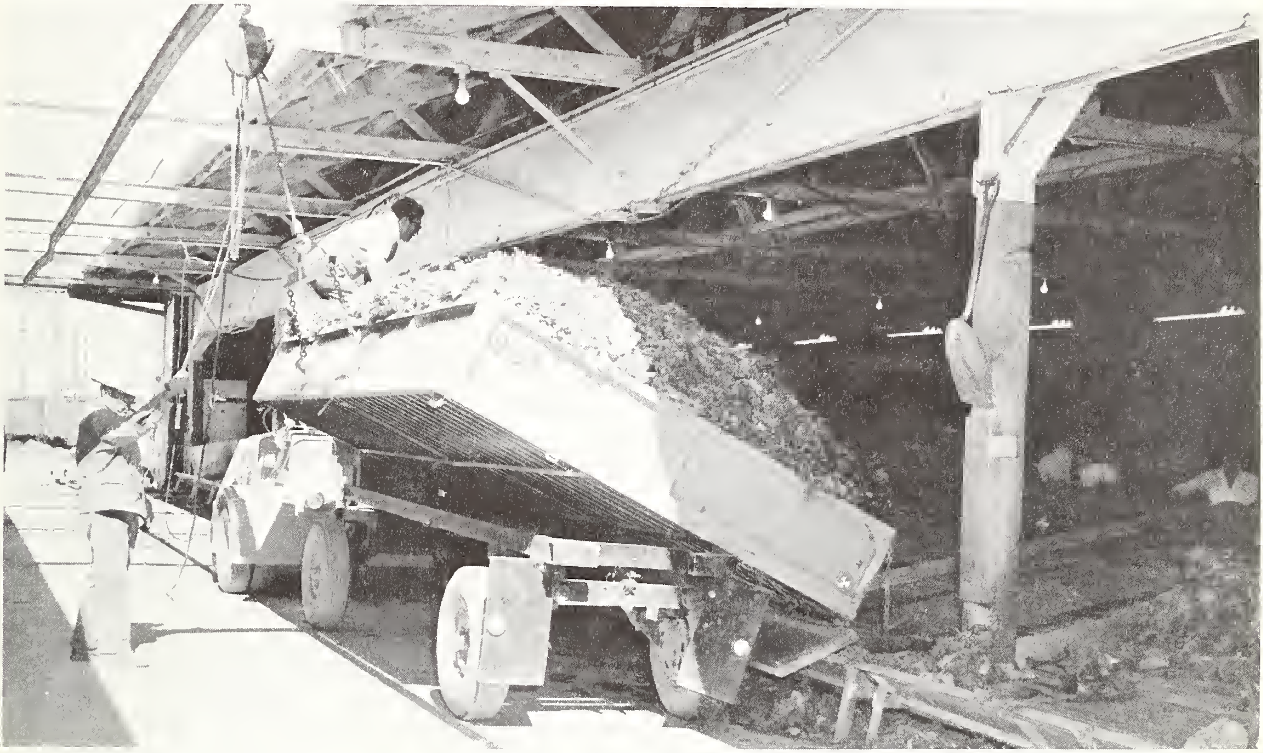
Whether the packaging was done in the field or in the sheds, most of the operations were the same. The greatest difference occurred in the manner in which the lettuce was trimmed and supplied to the packaging line.

Harvesting and Trimming for Shed Packaging

For the shed packaging operations, the lettuce heads were cut with six to eight wrapper leaves left on. The heads were tossed into large metal bins or low-bed trailers and transported to the sheds.

The sheds that used bins were generally those which packed cauliflower, celery, and broccoli or were left over from the days when lettuce was ice packed in the sheds. The bins carried the heads directly to the packaging line where they were hoisted and tilted so the trimmers could reach in and pick them up. The bins fit eight to a truck, and each had a capacity of 40 to 50 dozen heads of lettuce.

The sheds that used the low-bed trailers generally had packaging lines that had been converted from cantaloup or celery operations. In these plants the trailers were tilted to spill the lettuce onto an elevator that carried it to a belt conveyor (fig. 2). A mechanical sweep pushed the lettuce off the conveyor into bins accesible to the trimmers. The trailers carried 100 to 140 dozen heads.



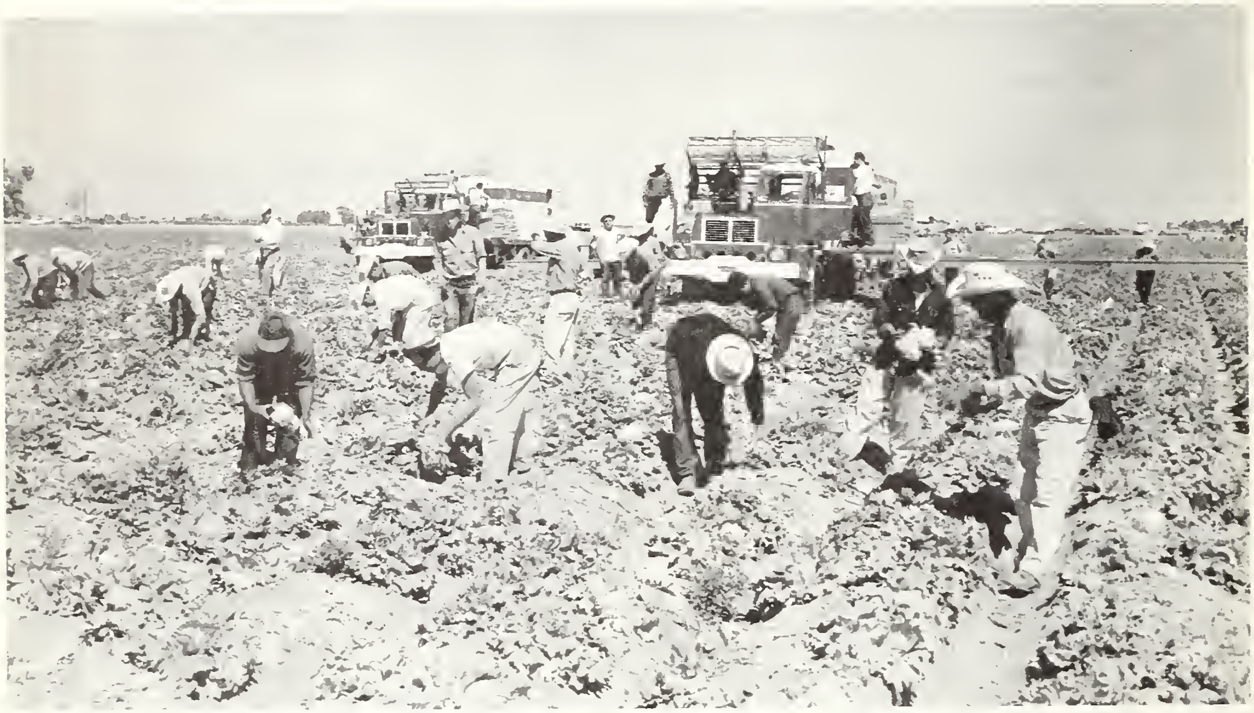
BN-44418

Figure 2.--Lettuce is unloaded at packing plant.

Trimming off the wrapper leaves was a time-consuming operation. The trimmers picked up the heads, cut off the leaves with a knife, trimmed the butts, and placed the heads on a conveyor belt or a platform within reach of the wrappers. The objective was to remove all wrapper leaves until the first good head leaf was exposed. Whenever possible, the first dark green cap leaf was left untouched because this color enhanced the appearance of the wrapped heads.

Harvesting and Trimming for Field Packaging

For the field packaging, the field workers who cut the heads of lettuce also trimmed them. When lettuce was prepackaged, the cutters selected heads of the desired size and maturity, cut the head, then completely trimmed off the wrapper leaves and any injured head leaves. After the head was trimmed, it was placed on the beds (usually on a clean leaf) to be picked up by the machine crew (fig. 3).



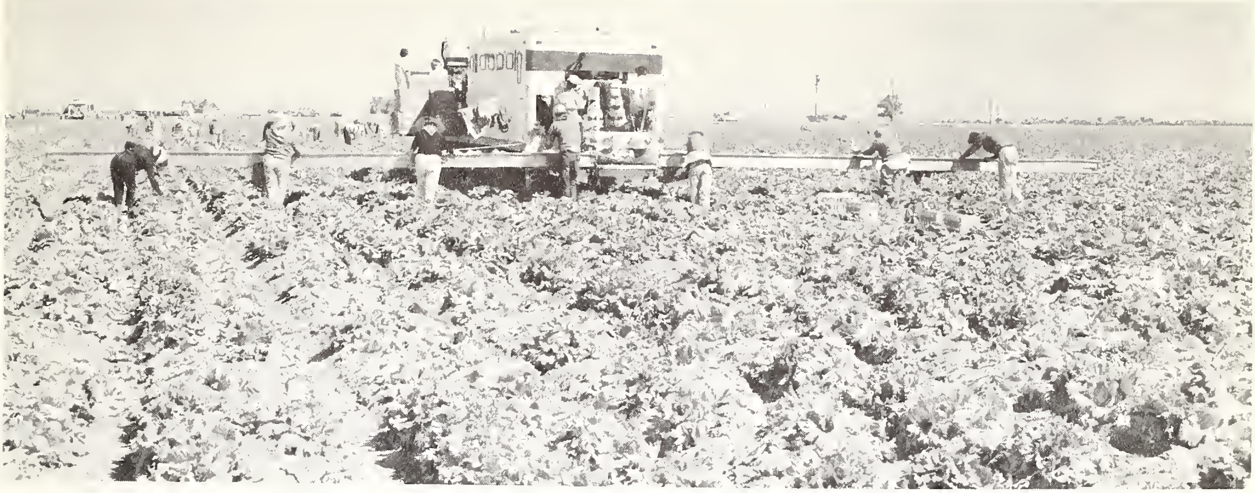
BN-44448

Figure 3.--Cutter-trimmers work down the rows ahead of mobile packaging plant.

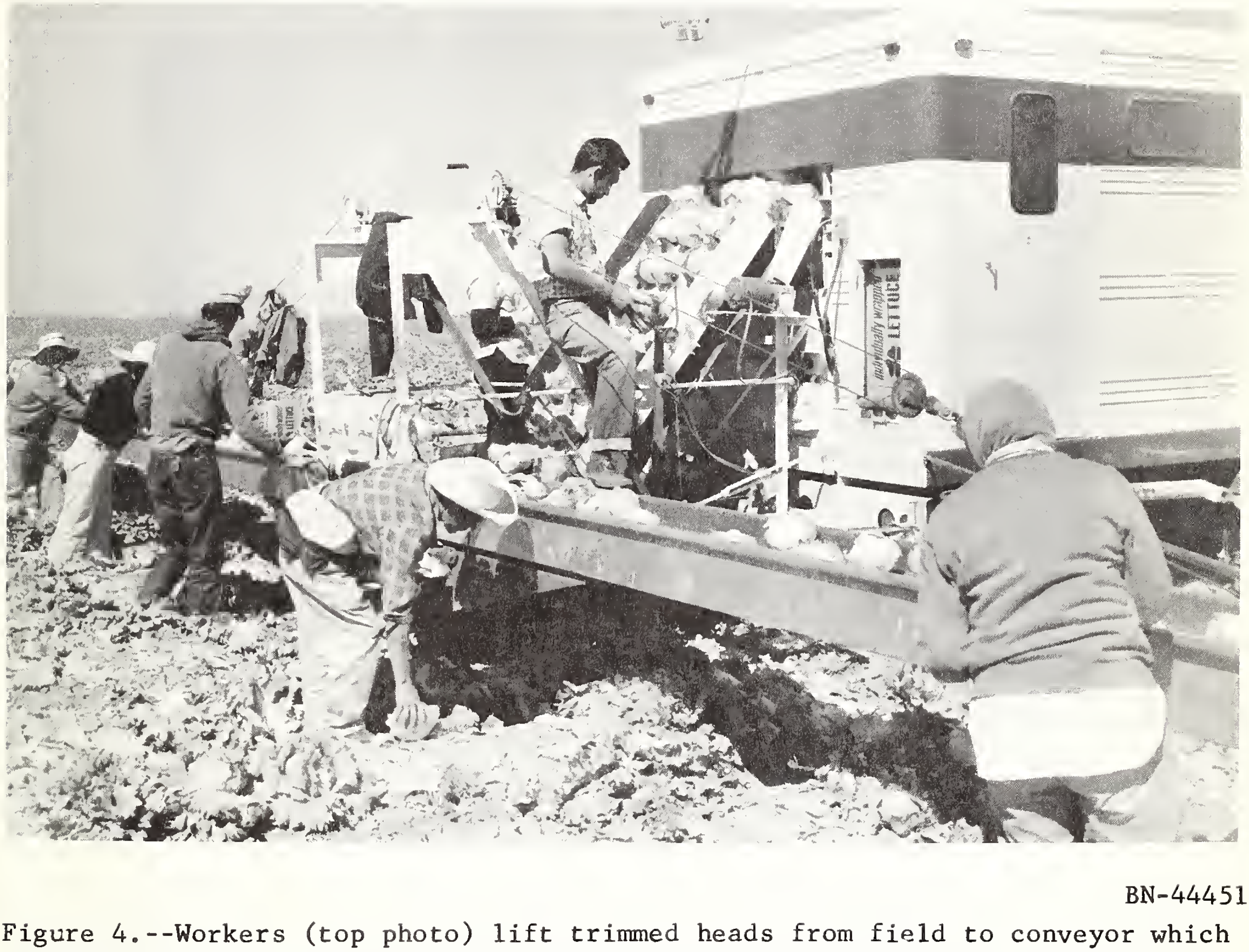
After the lettuce was cut and trimmed, workers following the cutters picked up the heads and placed them on a conveyor belt that carried them to the wrappers inside the mobile packaging plants (fig. 4).

Wrapping

Practically all the lettuce prepackaged in polystyrene film was wrapped manually. Some semiautomatic equipment was tried but none proved practical. The round shape, the range in sizes, and delicate nature of lettuce heads and the relatively high speeds required for packaging them have proved to be difficult problems; also, polystyrene films have critical sealing temperatures and tend to form hard and brittle masses when too much heat is applied to excessive overlaps. However, at the time this was written several manufacturers were developing automatic wrapping machines which showed promise. In 1963,



BN-44453



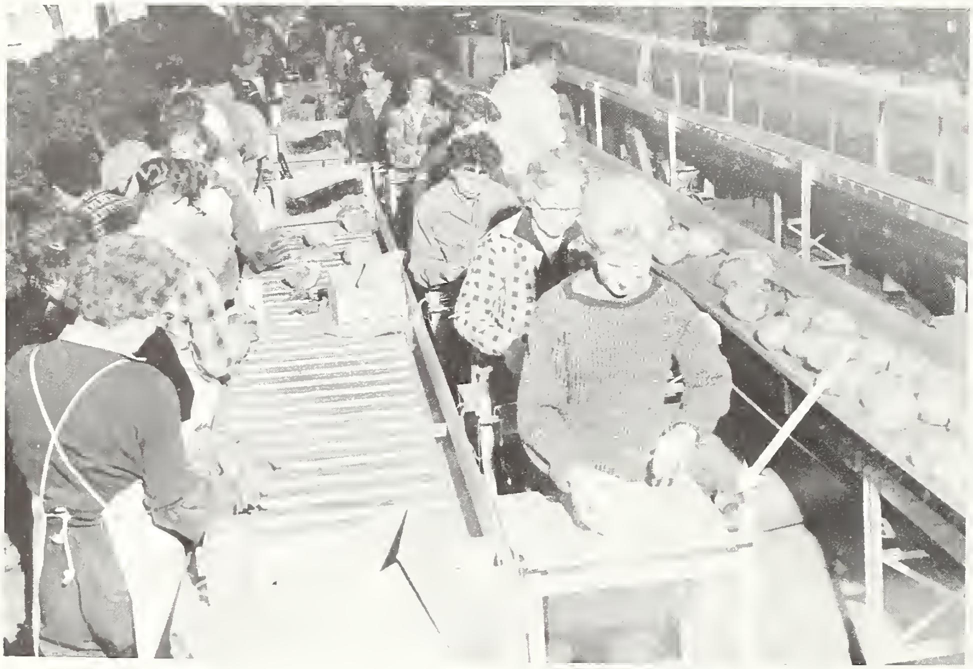
BN-44451

Figure 4.--Workers (top photo) lift trimmed heads from field to conveyor which extends out from rear of moving packing plant. Bottom photo is closer view of pick-up crew and conveyor. Foreman (seated) inspects heads as they are raised from outside to inside conveyor.

some commercial growers in California began wrapping lettuce in perforated extruded polyvinyl chloride with a semiautomatic machine.

Whether the wrapping was done in the shed or in the field, there were fundamentally two manual techniques. The older and more common method employed a wrapping table with an attached electric hotplate. The second technique was the "punchboard" system which required two workers. Both methods were used in both shed and field packaging operations.

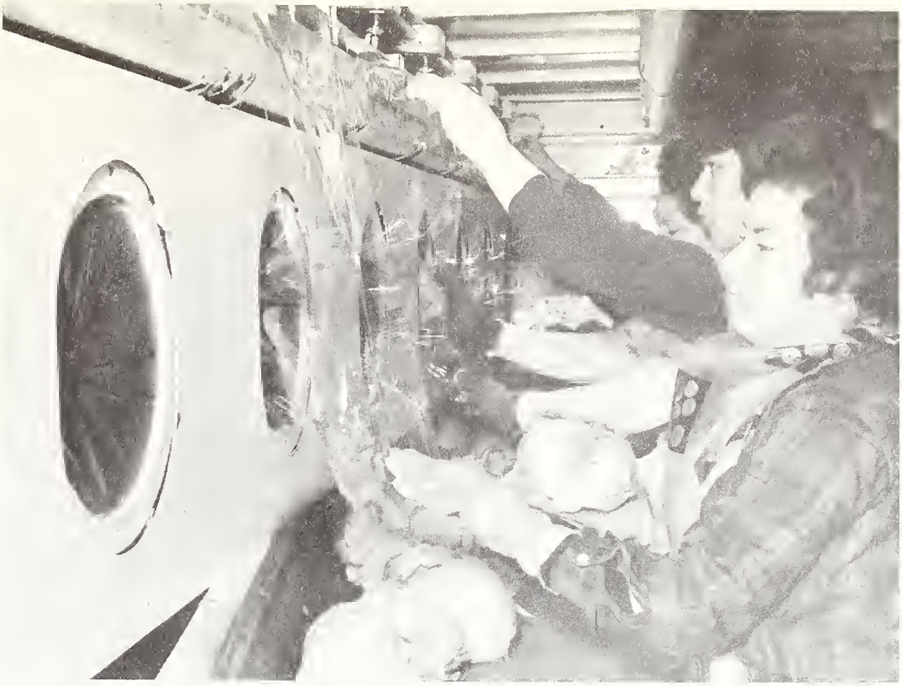
Wrapping Table Method--The wrapping table has been used for a number of years for prepackaging cauliflower. In its simplest form, the equipment consists of a flat table (approximately 20 by 20 inches) with a small electric hotplate or cylinder attached (fig. 5). Later improvements include a dispenser for film in roll form and a sliding knife or hot wire to sheet the film. Later, when this type of wrapping station was used with polystyrene film, it was found that hot wires could be positioned to sheet the film automatically.



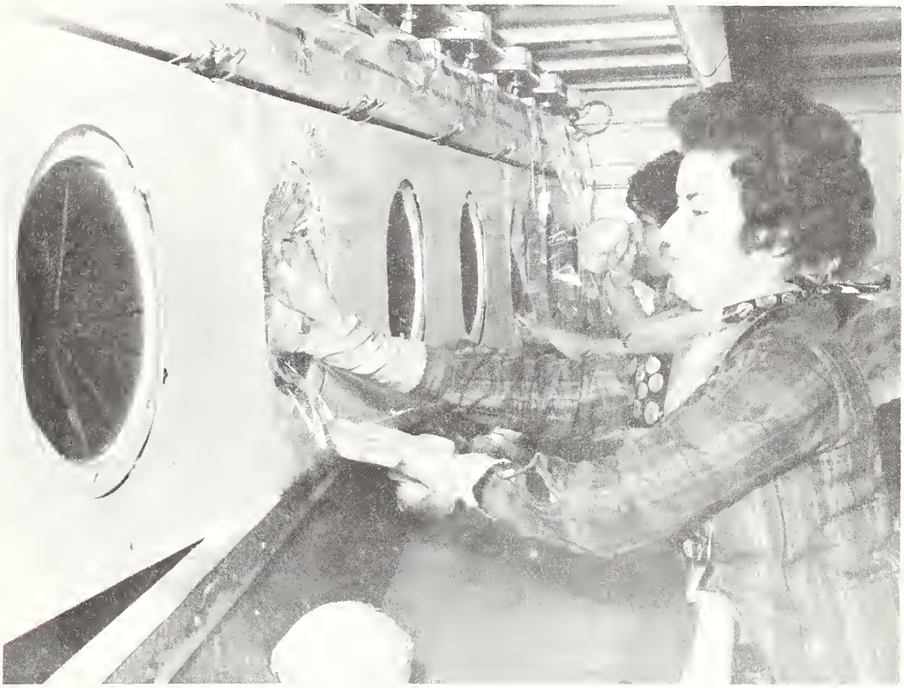
BN-44414

Figure 5.--Mass production wrapping table operation in shed is shown here. Arrow indicates hot cylinder which seals film. Workers at left trim lettuce. Wrapped heads go on conveyor at right.

The workers pull off a sheet of film which is cut to correct length, either automatically or by pressing a switch. The operators then place a head of lettuce on the sheet, wrap it, gather the folds, and draw the head across the hotplate or hot cylinder to seal the overlapped film.



BN-44440

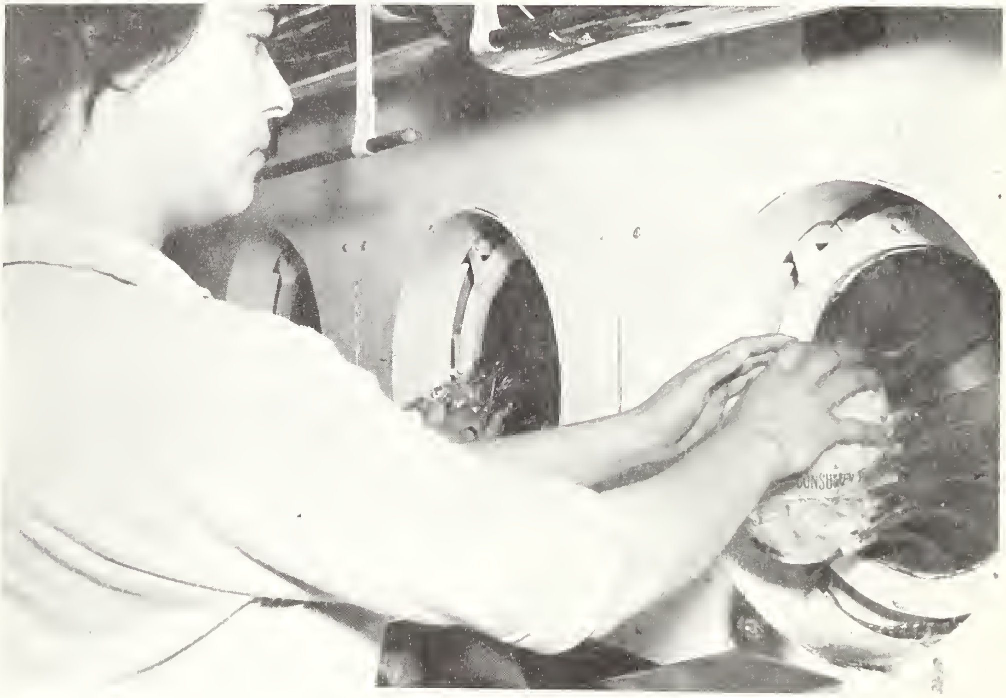


BN-44439

Figure 6.--Above, film is drawn down over hole in wall of mobile packing plant. Below, head of lettuce is pushed against film and through hole in wall.

Punchboard Method--The punchboard operations observed used a series of stations, each requiring two workers. One stood or sat on one side of a wall and a second worker was directly opposite on the other side. On one side of the wall a roll film dispenser was mounted above the workers; a hot cutoff wire was directly below the dispenser and under the hot wire was a round hole in the wall covered with heavy rubber that was cut into pie-shaped segments. On the opposite side of the wall a heat sealer was mounted a few inches below and away from the hole.

The first worker drew the film down over the hole, then picked up a head of lettuce and pushed it against the sheet of film and through the hole (fig. 6). Pushing the head against the film pressed the film against the hot cutoff wire and severed it to the required length. The pie-shaped segments of rubber acted like fingers dragging against the film, shaping it around and against the head. The second worker on the opposite side grasped the head and pulled it completely through the hole. Her fingers extended around the head, completely overlapping the excess film while simultaneously turning the head in a forward rolling motion that dragged the overlap across the heat sealer (fig. 7).

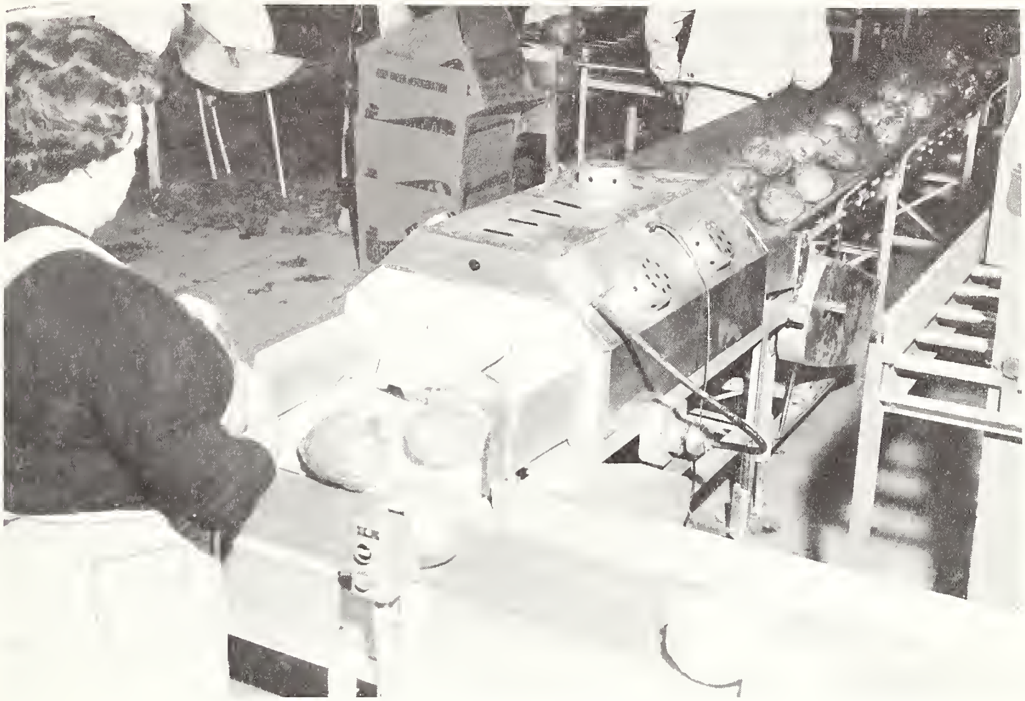


BN-44438

Figure 7.--Girl on other side of the wall is completing wrap and will seal film on hotplate which is partially visible below her forearm.

Shrinking the Film

After the heads were wrapped with polystyrene film they were placed on a belt that carried them through a hot air chamber called a heat tunnel (fig. 8).



BN-44423

Figure 8.--Wrapped lettuce, moved by conveyor, is inspected as it emerges from heat tunnel in packing shed.

No one type of tunnel was used. A number of companies manufactured various types and most of them were modified by the packers to fit their operation. Basically, these tunnels are sheet metal chambers that use either high-resistance wire heating elements or solid metal heating elements. Thermostats control the amount of heat produced and fans or impellers circulate the hot air around the packages. To conserve heat, cloth flaps are mounted in the openings through which the lettuce passes.

In the packaging operations observed, the size of the tunnels ranged between 15 by 18 inches with 4,000-watt heat capacity and 22 by 48 inches with 10,000-watt capacity. In 1961, the thermostats were normally set between 300 and 350 degrees. In 1962, most of the lettuce packagers reduced the temperature to around 250 degrees, but the volume of lettuce passing through the tunnels was generally beyond the capacity of the heat-generating units, so the effective temperature was usually lower. The belt speeds were usually adjusted to move the heads through the tunnel in 2 to 3 seconds.

Excessively high temperatures damage the outer leaves of the lettuce. Lower temperatures do not shrink the film as tightly around individual heads, but this does not detract from the appearance of the package and the lettuce.

Since the chambers were opened continually by the product passing through the cloth flaps, the maintenance of shrinking temperatures was difficult when the fields were cold and windy. The packers overcame this difficulty by increasing heat capacity, by insulating the chambers, or by building protective enclosures around the chambers.

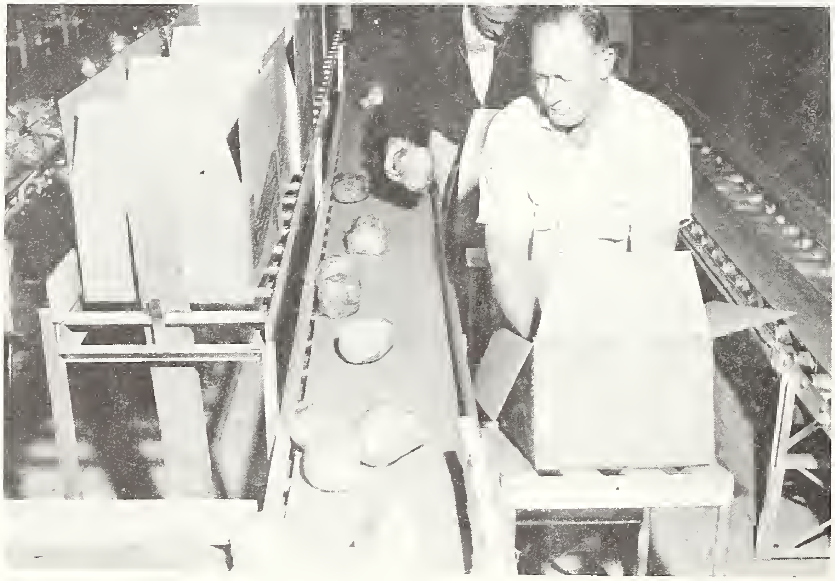
Assembling, Packing, and Closing the Shipping Containers

The shipping containers were usually assembled by a two-man team. One man opened the box, folded the flaps, and passed it to the second man, who either stapled the bottom flaps on a post stitcher or, if the flaps were coated with pressure sensitive glue, hit the flaps with a mallet.

In the field, the boxes were assembled either on the mobile packaging plants or on trucks accompanying them. In either case, supplying the boxes to the packers did not require additional labor.

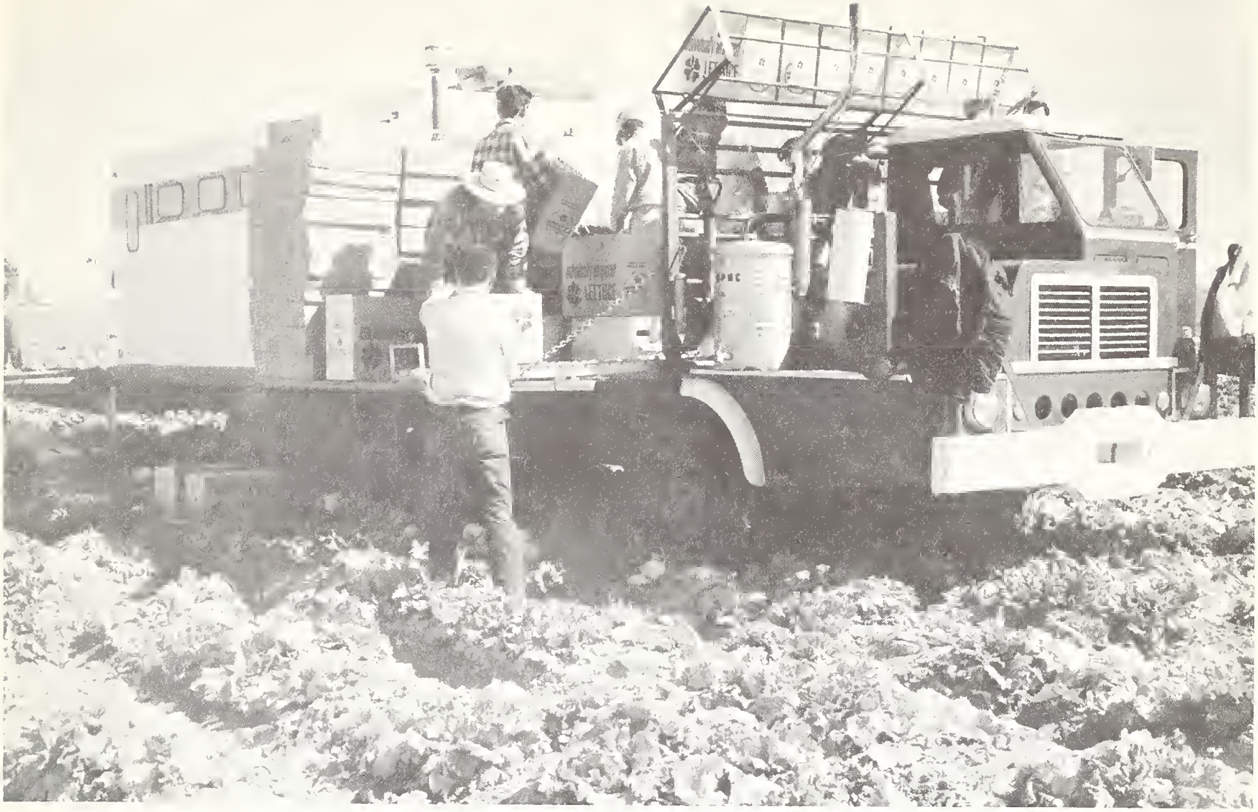
In some sheds the boxes were assembled close to the packers and in others the boxes were assembled at a central location and then distributed. The method used depended on the amount of space available.

The packing stations were located at the end of the packaging lines. Some packers worked with only two sizes of lettuce at a time--2 dozen and 1½ dozen, or 2 dozen and 2½ dozen--while others packed three or four sizes (fig. 9). The number of heads packed in a box and the number of sizes packed

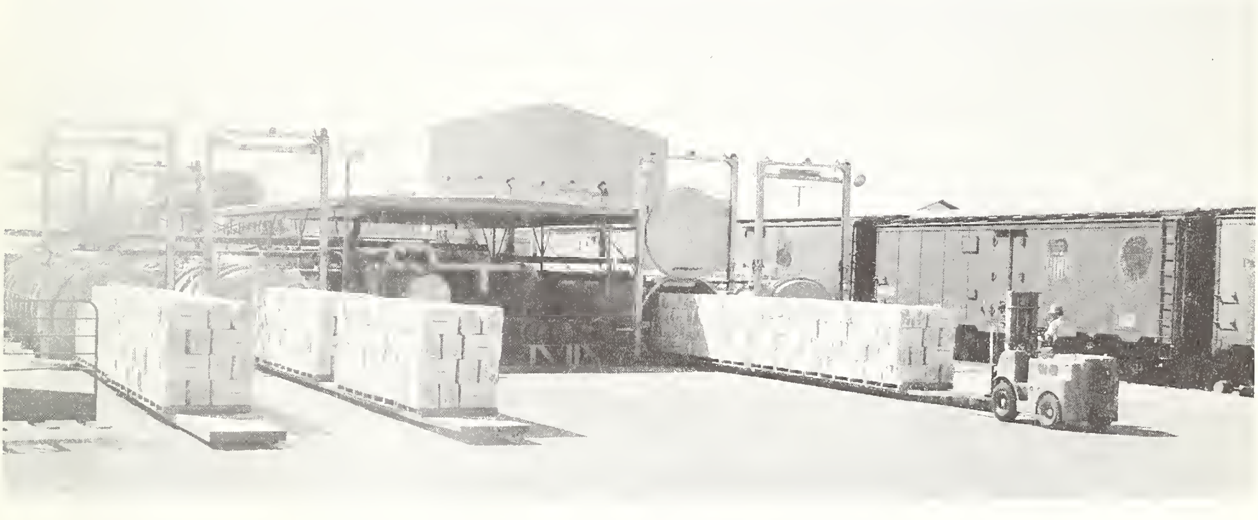


BN-44421

Figure 9.--Wrapped heads are packed 18 to 30 per shipping container in packing shed.



BN-44441



BN-44373

Figure 10.--At top, box is lowered to ground in field to await pickup by truck. Below, boxes are pushed into vacuum cooler by forklift truck.

depended on the size of the particular lot of lettuce. A few shippers attempted to pack most of their lettuce 20 heads to the box.

The standard No. 7306 boxes were packed with two layers. Some shippers packed the heads in the conventional manner with bottom layer butts down and top layer butts up. Others packed the bottom layer butts up and the top layer butts down so that when the boxes were opened the more attractive tops of the heads were visible. Side-opening cartons were usually packed with four layers of six heads. Some shippers tried jumble packing by guiding the flow of lettuce off a belt directly into a box, but this practice seems to be diminishing.

In shed operations the packers did not close the boxes. On mobile field packaging machines, however, the packer hammered down the pressure sensitive glued top flaps with his hands and turned the box over on a short conveyor belt. Another worker lowered the box to the ground to await pickup by the trucks that would take it to the vacuum coolers (fig. 10).

Quality Control

Quality control is more important for prepackaged lettuce than for the unwrapped pack. Unwrapped lettuce is trimmed--andoccasionally washed--by the retailer just before he displays it. Thus, a few discolored or broken leaves, or some dirt left on the heads at time of packing are not too objectionable. However, a prepackaged head of lettuce is the final product that the consumer will see and when delivered to the store, the head must be free of dirt and discolored or broken leaves. The clear film wrap tends to magnify each defect and, because of the higher relative humidity maintained within the package, certain types of defects become progressively worse during the distribution period. For example, an outer leaf with a rib nicked by a knife tends to discolor rapidly when exposed to higher temperatures in retail stores 7 to 9 days after packing.

When the lettuce is prepackaged at shipping point, the trimming operation is the most important single factor in the control of quality. For this reason, the trimmers are carefully trained and supervised. If a head is improperly trimmed when it reaches the wrapper, it is retrimmed. The wrapped heads are again checked by quality control inspectors before they are packed in shipping containers. The shrink tunnels are also checked frequently to insure that correct temperatures are maintained.

DIRECT LABOR REQUIREMENTS AND COSTS

Direct labor is the labor actually needed to do a job and in this study includes a 15-percent allowance for personal time and fatigue. It does not include supervisory time, time to drive vehicles, or uncontrolled, nonproductive time caused by delays, yield variance, or field conditions.

Unwrapped

An example of the composition of a conventional harvesting crew and the observed direct labor required to cut, trim, pack, and load a carton of 24 unwrapped heads follows:

Operation	Number of workers	Man-minutes
Cut and trim heads........................	32	3.84
Consolidate heads for packers..............	2	.23
Pack lettuce on single-wheel platforms.....	16	2.08
Wash top layer butts and place pads........	2	.18
"Square up" cartons and close.............	4	.54
Assemble box and staple bottom............	2	.21
Distribute cartons to packers.............	2	.23
Consolidate cartons and load truck........	4	.46
Total.....................	1/64	7.77

1/ Crews seldom are bigger, but often may be smaller.

At a wage rate of $1.35 an hour--the average of the rates observed for different types of jobs, different types of labor, and in various growing areas--the 7.77 man-minutes represent a direct labor cost of 17.5 cents to harvest and pack a box of 24 heads of unwrapped lettuce.

The computed labor cost of 17.5 cents a box is lower than most shippers report for these reasons: Nonproductive time was not included; the crew observed in the study was well trained; field conditions were good; and the yield per acre and the quality of the lettuce were high.

Wrapped

Lettuce was prepackaged either in a mobile plant on wheels which rolled slowly through the harvest field close on the heels of the cutters, or in a conventional packing shed. Crews for the field operation ranged from 30 to 64 workers, depending on the type of the mobile plant. Shed crews ranged from 25 to 92, exclusive of harvesters (table 2).

Time studies were made in four packing sheds with crews of varying training and experience. It was possible to make a time study of only one field-pack operation. It had a well trained and experienced crew of workers.

Table 2.--Number of workers packing lettuce in 3 mobile plants in fields and in 4 packing sheds, by type of operation performed, California, 1961-62

Operation	In fields			In sheds			
	A	B	C	D	E	F	G
Cut and trim heads	12	15	25	--	--	--	--
Trim heads	--	--	--	11	12	27	45
Supply heads to wrappers	4	4	9	1	1	2	2
Wrap heads	8	12	20	8	8	14	32
Assemble and supply cartons	1	2	2	1	1	2	3
Pack, stamp, close carton	4	2	4	--	--	--	--
Set off box	1	1	2	--	--	--	--
Pack box	--	--	--	1	2	3	6
Close, stamp, set off box	--	--	--	2	2	2	2
Control quality	0	1	2	1	1	2	2
Total	30	36	64	25	27	52	92

The direct labor time per box to wrap lettuce in the field and in packing sheds, by operations, is shown below:

Operation	Shed pack (4-plant average)	Field pack (1 shipper)
	Man-minutes	Man-minutes
Cut and load heads in bins or trailers	4.21	--
Cut and trim heads	--	4.58
Lettuce supply or lettuce pickup	.48	1.35
Trimming lettuce	5.99	--
Wrapping	3.85	2.95
Box supply	.18	--
Pack	.52	--
Pack, stamp, and close	--	.77
Close, stamp, and setoff	.50	--
Setoff	--	.30
Quality control	.38	.45
Box assembly	.21	.28
Total	16.32	10.68

At the average wage rate of $1.35 an hour, the 10.68-minute requirement for the field pack represents a cost of 24.0 cents for direct labor to prepackage and box 24 heads, and the 16.32 minutes for the shed pack reflects a direct labor cost of 36.7 cents for 24 heads. As indicated above, cutting and trimming operations are performed more efficiently if the lettuce is prepackaged in the field instead of in the sheds. This is because lettuce harvested for prepackaging in the field was cut high, leaving at most only one or two wrapper leaves to be trimmed. Hence, the same man who harvested the lettuce could spot defects immediately and decide to remove them or discard the head. In contrast, lettuce harvested for prepackaging in the sheds was cut with almost all wrapper leaves left untouched to protect the heads. Workers in the sheds later trimmed off these leaves and retrimmed the butts. When they discovered defects, they attempted salvage by further trimming before deciding to keep or discard the head.

Factors Affecting the Efficiency of Prepackaging Lettuce

Quality and Yield--The effect of variations in the quality of lettuce on direct labor used to trim it is shown below:

Lettuce quality	Direct labor per 24 heads	Rate of trimming
	Man-minutes	Heads per minute
Excellent	3.6	6.7
Good	5.5	4.4
Poor	9.0	2.7

Dirt deposited on the lettuce by rain or high wind also slows the trimmers. Dust raised by traffic on access roads settles on heads in nearby fields and adds to the problem.

Growers interviewed reported that lettuce yields ranged from 350 to 650 packed boxes per acre. Records of packers showed that the cost of harvesting, trimming, and packing a box of lettuce from fields with very poor yields can be four times greater than the cost of packing from fields with high yields.

Plant Layout and Equipment--One shed placed the lettuce supply table and the conveyor belt taking away the wrapped heads at the same height and within easy reach of the wrapping table. The film was dispensed from a roll and the sheets were cut by a hot wire. The hotplate was flush with the table top. The workers' motions were smooth and easy when they dispensed a sheet of film, picked up a head of lettuce with one hand, wrapped it with both hands, and in one almost continuous motion sealed the wrap and placed the head on the conveyor belt with the other hand. As a result, the wrappers were able to attain speeds of up to 13 heads per minute, and a line of wrappers averaged 7.6 heads per worker per minute during an entire day, including rest time and allowance for fatigue.

In another shed the wrapping table, supply conveyor, and hotplate were at different heights. This arrangement required an awkward reach both to pick up a new head of lettuce and to flick the knife which cut the film to the desired length. The fastest workers could wrap no more than 10 heads a minute and the entire line averaged but 6 heads--20 percent fewer than in the first plant. If each plant employed 20 workers on its packaging line, the hourly output in the first would be 1,920 heads or 80 cartons greater than in the second.

Another good example of the importance of efficient planning and coordination was the punchboard wrapping operation in a mobile field plant. The movements of the wrappers working through the hole in the wall were fluid and seemingly effortless. Some teams of two girls packaged 22 to 24 heads a minute over substantial periods of time. A study of one production line indicated that each worker could wrap an average of 8.1 heads per minute throughout the day. Sheeting the film and punching the head through the wall required more time than completing the wrap and sealing it, which created a slight imbalance. An automatic film dispenser, if developed, would lighten the task of the first worker, correct the imbalance, and further speed the entire operation.

Quality and Supply of Labor--In general, sheds use local labor, mostly housewives. Hence, sheds are able to maintain reliable, well-trained crews who, for the most part, are willing to work irregular hours and can be called to work with short notice. In contrast, the supply of migrant labor for field crews often is uncertain, and the workers may be inexperienced. To keep field crews ready, in anticipation of future needs, the growers maintain them through slack periods. Availability of the desired type and quality of laborers as well as the degree of training and supervision given them is an important factor affecting the cost of prepackaging lettuce.

Nonproductive Time--Occasionally some or all of the workers are idled by adverse conditions in the field or delays in packing sheds resulting from uneven supplies of lettuce. Poor quality lettuce, wet patches which mire the field packaging machine, and short fields which required frequent turns at the end of the rows were all observed as causes of nonproductive time. Other factors, such as high winds which blow the film about and slow down the wrappers or make it impossible to wrap lettuce, also cause nonproductive time. The amount and cost of such time, however, was not determined.

COMBINED COSTS OF PACKAGING MATERIALS AND DIRECT LABOR

The combined costs of materials and direct labor for the conventional field pack of 24 heads of unwrapped lettuce and for the field pack and shed pack of wrapped lettuce were as follows:

Item	Nonwrapped	Wrapped	
		Field pack	Shed pack
	Cents	Cents	Cents
Materials	26.55	50.24	50.24
Labor:			
Field pack	17.50	24.00	---
Shed pack	---	---	36.70
Total	44.05	74.24	86.94

These costs do not include equipment, depreciation, taxes, interest, insurance, or other overhead.

TRANSPORTATION COSTS

Carloads of unwrapped lettuce usually range between 640 and 960 boxes, depending on the size of the refrigerator cars. More boxes of wrapped lettuce can be loaded because the trimmed heads fit easily in the shipping containers, and tops, bottoms, and sides of the boxes do not bulge. Shippers reported that loads of wrapped lettuce ranged from 700 boxes in the standard ice bunker car to 1,300 boxes in the larger mechanical refrigerator car.

Table 3 summarizes the cost of shipping unwrapped lettuce and trimmed wrapped lettuce from California to New York City in cars with various loads. Freight and refrigeration savings obtained by prepackaging lettuce were substantial.

Table 3.--Railroad transportation charges for wrapped lettuce and unwrapped lettuce in fiberboard boxes from Salinas, Calif., to New York City, 1962

Type of pack and type of car	Boxes per car	Gross weight 1/	Heads per car (24 per box)	Freight and refrigeration charges 2/		
				Per carload	Per box	Per head
	Boxes	Pounds	Heads	Dollars	Dollars	Cents
Unwrapped:						
Standard ice bunker car.....	700	32,900	16,800	916.97	1.310	5.46
Mechanical refrigerator car.	960	45,120	23,040	1,078.47	1.123	4.68
Wrapped:						
Standard ice bunker car.....	840	27,090	20,160	828.72	.986	4.11
Standard ice bunker car.....	700	22,575	16,800	710.88	1.016	4.23
Single ice bunker car.......	940	30,315	22,560	882.58	.939	3.91
Mechanical refrigerator car.	1,300	41,925	31,200	1,044.02	.803	3.35

1/ Unwrapped lettuce was billed at an estimated weight of 47 pounds per box. Wrapped lettuce was billed at actual weight; an average of 32.25 pounds per box was used to calculate the gross weight.

2/ Weight incentive freight rates per 100 pounds were as follows: 20,000 lb.--$2.61; 30,000 lb.--$2.51; 33,000 lb.--$2.41; 36,000 lb.--$2.31; 40,000 lb.--$2.20; 43,000 lb.--$2.14; 46,000 lb.--$2.08; and 50,000 lb.--$2.02. The charge for standard refrigeration was $121.67 and this amount was added to freight charges. One-half stage standard refrigeration would cost $95.00.

Loads of 700 boxes of the unwrapped pack or 840 boxes of wrapped lettuce in the standard ice bunker car were typical of the commercial loading practices observed. At this level the savings on the wrapped lettuce were 32 cents per box. Some receivers did not want as many as 840 boxes of wrapped lettuce in a single shipment, but even in a 700-box load the saving was 29 cents a box. Receivers who wanted more than the 840 boxes of wrapped lettuce normally loaded in the standard car frequently ordered 940 boxes in the single ice bunker car. In this case the saving was 37 cents a box.

In 1962, California and Arizona producers shipped about 100,000 carlot equivalents of lettuce by rail and by truck. If but half the lettuce in the rail shipments had been trimmed and prepackaged, it is estimated that savings in transportation would have approximated $6 million.

VACUUM COOLING WRAPPED LETTUCE

Vacuum cooling is the accepted method of precooling western lettuce. As with unwrapped lettuce, the cooling of packaged lettuce depends on the evaporation of water from the leaves. 4/ When lettuce is wrapped, the film restricts the free passage of water vapor from the lettuce and slows the rate of cooling. Consequently, some form of ventilation is required.

Initial tests compared unwrapped lettuce and lettuce wrapped in four types of film--each film perforated with 1/4-inch holes and unperforated. The lettuce was "hard" (dense). Such heads are difficult to cool. Temperatures were taken with pulp thermometers inserted into the heads. One test was made in Salinas and one in Watsonville.

After an average of 19-1/2 minutes in the two vacuum coolers the temperature of unwrapped lettuce fell from an average of 55.0° F. to 34.0°. Heads wrapped in film fell from 55.0° to these levels:

Type of film	Perforated	Unperforated
	°F.	°F.
Polystyrene, shrunk, 1-mil	34.8	38.4
Extruded polyvinyl chloride, unshrunk, 3/4-mil	36.0	42.2
Cast polyvinyl chloride, shrunk, 1/2-mil	35.6	43.7
Irradiated polyethylene, shrunk, 1-mil	36.9	43.7

Lettuce wrapped in perforated film cooled more rapidly than lettuce in unperforated film. Heads in the vented films were only 0.8 to 2.9 degrees warmer than the unwrapped lettuce. When the films were not perforated, the final temperatures of the wrapped lettuce ranged from 4.4 to 9.3 degrees higher than that of unwrapped heads. Lettuce in the polystyrene showed the least difference from unwrapped heads and was 3.8 to 5.3 degrees colder than heads in the polyethylene and two types of polyvinyl chloride.

4/ Barger, W. R., "Factors Affecting Temperature Reduction and Weight Loss in Vacuum-Cooled Lettuce" U.S. Dept. Agr. Mktg. Res. Rpt. 469, April 1961. This report contains an excellent discussion of the principles of vacuum cooling.

These differences in temperature were brought out more clearly in 27 additional observations made in commercial vacuum coolers in 1961 and 1962 (table 4).

Table 4.--Average temperatures after vacuum cooling of lettuce wrapped in plastic film and unwrapped lettuce, Salinas and El Centrol, California, 1961-62

Type of film overwrap	Number of tests	Temperature before cooling	Average cooling time	Temperature after cooling	Unwrapped control after cooling
	Number	°F.	Minutes	°F.	°F.
1-mil polystyrene, unperforated shrunk	14	61.5	19.6	37.4	35.8
Extruded 3/4-mil PVC, perforated not shrunk 1/	5	62.7	19.2	36.3	35.3
Cast 1/2-mil PVC:					
Unperforated, shrunk	2	65.6	19.0	45.9	35.7
Perforated, shrunk 2/	3	61.8	18.7	35.8	36.1
Irradiated polyethylene, 1-mil:					
Unperforated, shrunk	1	60.0	18.0	47.0	35.0
Perforated, shrunk 3/	2	60.5	18.0	35.1	36.2

1/ Each sheet of PVC, an abbreviation for polyvinyl chloride, had approximately 25 perforations, the equivalent of 1/8-inch in diameter. A roller perforator made a V-shaped cut and did not remove film from the hole. Although the flap that remained partially closed each hole, enough of an aperature remained so that water vapor passed through freely.

2/ The manufacturer supplied film with 1/16-inch perforations on 1/2-inch centers.

3/ About ten 1/4-inch perforations were in functional locations.

Polystyrene film--Lettuce wrapped in unperforated polystyrene averaged 1.6 degrees higher than unwrapped lettuce. The differences ranged between 0.2 degrees cooler and 9.0 degrees warmer.

Extruded polyvinyl chloride (PVC)--Temperatures of lettuce in this perforated film averaged 1 degree higher than unwrapped lettuce; the difference ranged between 0.5 degrees cooler and 2.2 degrees warmer.

Cast polyvinyl chloride (PVC)--When this film was not perforated, temperature of the packaged lettuce averaged 10.2 degrees higher than the unwrapped lettuce. However, in the perforated film, the wrapped lettuce cooled as fast as the unwrapped.

Irradiated polyethylene--In one test with unperforated film, the wrapped heads averaged 12 degrees higher in temperature than the unwrapped heads. When this film was perforated, the wrapped lettuce was cooler than the unwrapped lettuce in one test (35° vs. 37.5°), and was almost the same temperature in the second test (35.2° vs. 35.0°).

The faster cooling of the lettuce in the unperforated polystyrene than in the other unperforated film led to the belief that considerable amounts of water vapor were passing through imcomplete seals in the polystyrene wrap. This belief was confirmed by a test in which seven heads of "hard" lettuce were carefully wrapped and sealed in unperforated 1-mil polystyrene film in an effort to get as airtight a seal as possible. After 19-1/2 minutes' cooling time, the temperature of the wrapped heads ranged between 39 and 48 degrees and averaged 43.8° F.; comparable unwrapped lettuce ranged between 35 and 39 degrees and averaged 36.3 degrees. This 7.5-degree difference in temperature between polystyrene-wrapped lettuce and unwrapped lettuce was considerably higher than the 4.4 degrees in the two initial tests and the 1.6 degrees in 14 subsequent tests when no special effort was made to get tight seals.

CONDITION OF LETTUCE AT TERMINAL

The first of a continuing series of test shipments to evaluate the comparative suitability of various types of film as a wrap for lettuce was made in August 1960. It contained three boxes--one with lettuce wrapped in open polyethylene bags, the second with lettuce wrapped in irradiated polyethylene film, and the third with lettuce wrapped in shrinkable polystyrene film. The lettuce was shipped from California to a corporate food chain in the East and was inspected after delivery to retail stores. Lettuce packaged in polyethylene bags and in shrinkable irradiated polyethylene film showed some decay. No decay was found in lettuce packaged in polystyrene film, which was more permeable to moisture transmission.

In a second test the lettuce was prepackaged in polyethylene bags, shrinkable polystyrene film, and shrinkable cast polyvinyl chloride film. Again, less decay developed in the polystyrene film packages. The lettuce, packaged September 8, arrived in Philadelphia on September 16 and was held in storage at 55° F. for 7 days. At the end of this period, 96 percent of the lettuce packaged in polystyrene was salable as compared to 92 percent packaged in polyvinyl chloride film and 71 percent in the polyethylene bags.

A third test shipment contained lettuce wrapped in irradiated polyethylene film, cast polyvinyl chloride, and polystyrene film. This lettuce was shipped October 12, arrived in New York October 20, and was held in the warehouse 5 days before it was inspected. At that time, 85 percent of the lettuce wrapped in polystyrene was salable as compared with 63 percent of the lettuce wrapped in either irradiated polyethylene or cast polyvinyl chloride.

By this time it appeared that the more moisture-permeable polystyrene film package had an advantage over the others in that it permitted escape of excessive moisture and therefore the lettuce in it was less vulnerable to slime and decay.

Consequently, the fourth test, made in January 1961, was designed to further evaluate polystyrene film of different thicknesses. The shipment contained 2 boxes wrapped in 1-1/4-mil polystyrene and 2 boxes wrapped in 1-mil polystyrene film. For each film, one box was wrapped after and one box was wrapped before vacuum-cooling. The condition of this lettuce upon arrival at the terminal was not affected either by the difference in the thickness of the film or by wrapping before or after cooling.

Condition on Arrival

Subsequent test shipments were then largely confined to 1-mil polystyrene film, which is cheaper than 1-1/4-mil gage. In 10 commercial shipments of unwrapped lettuce, varying numbers of test cartons of film-wrapped lettuce were included. Samples of 2 to 6 cartons of unwrapped and film-wrapped lettuce were examined in each shipment upon arrival in eastern markets. The samples totaled more than 1,200 heads. Transit time from California ranged from 5 to 8 days. Shipments were made in June, September, October, and November 1961.

The condition of the unwrapped heads and the heads wrapped in 1-mil polystyrene is detailed in table 6 in the appendix and averaged as follows:

Defect or condition noted	Unwrapped	Wrapped
	Percent of heads	Percent of heads
Bruising and discoloring of ribs:		
Very slight	27.8	27.7
Slight	15.7	9.1
Damage	1.6	0.7
Serious damage	0	0.1
Bruising and discoloring of leaves:		
Very slight	14.8	12.2
Slight	6.6	2.7
Damage	1.4	0.4
Serious damage	0	0
Decay	3.3	0.5
Perfect heads	30.8	41.1
Salable heads 1/	94.4	99.0

1/ Salable heads were all those having no decay and no damage by bruising or discoloring of ribs or leaves.

Total bruising and discoloration of ribs and leaves in the unwrapped lettuce was in excess of that in the film-wrapped lettuce. The difference in bruising, which was not statistically significant, seems to be the result of less crushing in the shipping containers. Wrapped lettuce is not packed so tightly as unwrapped lettuce. Also, presumably the film gives some protection to the leaves while being packed in the box and during transit.

The greater amount of decay in the unwrapped lettuce, an average of 3 percent compared with 0.5 percent in the wrapped lettuce, was found to reflect the only statistically significant difference in the tabulated averages. Usually more decay organisms are present in the outer than in the inner leaves of lettuce. When the outer leaves are trimmed off and the lettuce prepackaged in film, it is expected that there will be less decay when the lettuce arrives at the market.

Condition After Holding

Condition of the lettuce as it arrives in the terminal markets is important. It also is important to learn the condition of the lettuce after it has been held for a few days. Lettuce is very perishable and deteriorates rapidly unless held under favorable conditions. In commercial channels lettuce is not always held as it should be, and researchers wanted to know how well it held up under a variety of conditions. Lettuce often is held 2 or 3 days in wholesale channels, usually under some form of refrigeration, before it reaches retail stores. Some retailers provide good refrigeration in storage before the lettuce goes on sale, but others do not. Then the lettuce may be displayed in refrigerated cases, on beds of ice, or on nonrefrigerated stands.

Comparative salability of unwrapped lettuce and lettuce wrapped in polystyrene or extruded polyvinyl chloride on arrival at the Philadelphia terminal in October 1961, and after various periods of time at various temperatures was as follows:

Time held and temperature	Unwrapped	Wrapped	
		Polystyrene	Extruded PV
	Percent salable	Percent salable	Percent salable
On arrival at 39° F...............	97.3	100	100
Plus 1 day at 43°..............	94.5	1/	1/
Plus 2 days at 43°.............	94.5	100	100
Plus 5 days at 43°.............	94.5	83.3	94.5
Plus 1 day at 67°..............	88.9	1/	1/
Plus 2 days at 67°.............	44.0	77.8	81.3
Plus 5 days at 67°.............	0	22.2	12.4
Plus 1 day at 43° and 1 at 67°..	1/	94.5	83.3
Plus 1 day at 43° and 2 at 67°..	1/	83.3	61.2

1/ Not observed.

Detailed conditions on which these computations were based are listed in table 7 in the appendix. This test includes 2 boxes with a total of 36 heads of unwrapped lettuce, 3 boxes with 54 heads wrapped in polystyrene, and 3 boxes with 52 heads wrapped in extruded polyvinyl chloride. In these tests, lettuce was considered unsalable when inspection revealed damage by bruising or discoloring of ribs or leaves, or decay. The unwrapped lettuce deteriorated more rapidly than the film-wrapped heads at high temperatures. However, when lettuce was held at lower temperatures, packaging influenced salability very little. When lettuce is handled under adverse temperature conditions, its salability is maintained better and longer if it is packaged in the proper film.

The tests were expanded to determine the condition of the lettuce in a more complete range of temperatures and holding times. The comparative salability of unwrapped lettuce and lettuce wrapped in 1-mil polystyrene and in 3/4-mil extruded polyvinyl chloride film after 6 days in transit, from California to Philadelphia, in October 1961, and various holding periods at different temperatures was:

Time held and temperature	Unwrapped	Polystyrene	Extruded PVC
	Percent salable	Percent salable	Percent salable
On arrival at 41° F...............	81.2	100	95.8
Plus 1 day at 43°...............	75.0	100	87.5
Do. (different cartons).......	1/	100	91.7
Plus 3 days at 43°..............	37.5	100	87.5
Plus 1 day at 67°...............	58.3	95.9	95.8
Plus 3 days at 67°..............	25.0	37.5	37.5
Plus 1 day at 43° and 2 at 67°..	1/	91.7	50.0

1/ Not observed.

Details on the condition of the lettuce in this test are listed in table 8 of the appendix. This test included 2 boxes with a total of 48 heads of unwrapped lettuce, 3 boxes with 72 heads wrapped in polystyrene, and 3 boxes with 72 heads wrapped in extruded polyvinyl chloride.

The unperforated 1-mil polystyrene later was compared with perforated extruded 3/4-mil polyvinyl chloride and perforated cast 1/2-mil polyvinyl chloride. Lettuce in all films was found 100 percent salable upon arrival in Philadelphia with a temperature of 38° after 6 days in transit from the West Coast and it all remained salable during 2 days of holding at 65°. Following the third day of holding at this temperature, lettuce in the cast polyvinyl chloride was still 100 percent salable and in the other two films it was about 95 percent salable (table 9, appendix). Differences in the condition of the lettuce wrapped in the three types of film were not significant either at time of arrival or after holding.

In a cooperative laboratory test, pathologists of the Market Quality Research Division found no significant differences in condition or salability among heads of unwrapped lettuce and heads prepackaged in five different types of film (table 10, appendix). The lettuce, which was included in four test shipments from California to New York, was examined after being held 4 days at 44° F. and 1 day at 70°. This holding time simulated a fairly typical marketing period under good commercial conditions.

The films tested were 0.5-mil cast polyvinyl chloride, perforated and shrunk; 0.75-mil extruded polyvinyl chloride, perforated and not shrunk; 0.5-mil polypropylene, perforated and not shrunk; 0.6-mil polyethylene bags, perforated and not shrunk, and 0.85-mil polystyrene, shrunk and not perforated. The lettuce in these tests was harvested in November 1962, when moderately low temperatures were ideal for handling and shipping.

Discussion

The more permeable the film, the less likely is the development of decay, but dehydration and wilting are more likely. Less permeable films retain moisture that encourages the growth of decay organisms, but wilting in these films is less evident.

When the lettuce was of good quality, vacuum cooled to a desirable temperature around 35°, then shipped, stored, and handled under good refrigeration, no evidence was found that one film was better than another in prolonging shelf life of lettuce.

On the other hand, when the lettuce was of poor quality, when russeting, tipburn, or decay were present, or when the lettuce was marketed under unfavorable temperature conditions, the authors observed that the lettuce packaged in less permeable films such as semimoistureproof cellophane, polypropylene, and polyethylene usually deteriorated and became unsalable more quickly than when packaged in more permeable films. Excessive moisture, condensed inside the package, generally caused leaf and rib bruises to discolor noticeably and seriously impaired salability.

The foregoing statements are based more on observations of commercial shipments than of test shipments.

Since the quality of lettuce varies considerably throughout the year because of differing growing districts and changing climatic factors, it would seem the best policy to prepackage lettuce in films with fairly high moisture permeability rates or in less permeable films that are well perforated.

TRADE REACTION

An earlier report released by the Agricultural Marketing Service 5/ indicated widely differing wholesale and retail trade reaction to lettuce prepackaged at shipping point. Wholesalers and retailers continue to express a diversity of opinions on the merits of prepackaging lettuce.

Buyers at the produce auctions, mostly independent wholesalers, favored unwrapped lettuce because many of their customers were hotels and restaurants which were accustomed to trimming lettuce as they saw fit and they found no advantage in the package. Dealers who sold to independent stores were more inclined to buy the wrapped lettuce.

5/ "Lettuce Prepackaged at Shipping Point, A Preliminary Market Survey" U.S. Dept. Agr., AMS-481, June 1962.

Major support for shipping-point prepackaging came from chain store buyers and produce managers, but not all comments were favorable. The most frequent adverse criticisms were aimed at variation in the quality of the lettuce, and the irregular sizing of the heads.

"The shippers will have to enforce more rigid quality control," a chain store official said. "A small defect that passes unnoticed on an unwrapped head seems much more conspicuous in a film package."

In stores with a policy of selling a high percentage of prepackaged produce many comments indicated satisfaction with the opportunity to buy lettuce already prepackaged, thus freeing available store packaging labor for duties that would provide improved service for customers.

One produce manager, who reported that he liked buying lettuce prepackaged at shipping point, explained that it took him 3 hours to trim, package, and put on display 15 boxes of lettuce--his normal Friday sales. He said saving these 3 hours relieved a lot of tension and gave him a chance to do other chores which usually were neglected.

Another produce manager said he sold 30 to 40 cartons of lettuce a day on weekends, and that this required the full-time services of one employee. He hoped that problems could be worked out so he could be assured of getting regular deliveries of highly salable lettuce already packaged.

The manager of a New York City chain store said he preferred the polystyrene film because he thought the crackly sound of the film would help create the impression that the lettuce was fresh and crisp. The exact opposite reaction was voiced by a veteran produce man in another store. "The rattle of the film gives me the idea that the lettuce is dry and old," he said.

CONSUMER REACTION

There is great variation in consumer reaction to prepackaged lettuce. This is probably caused, in part, by the variety of ways in which lettuce has been offered to consumers over a number of years.

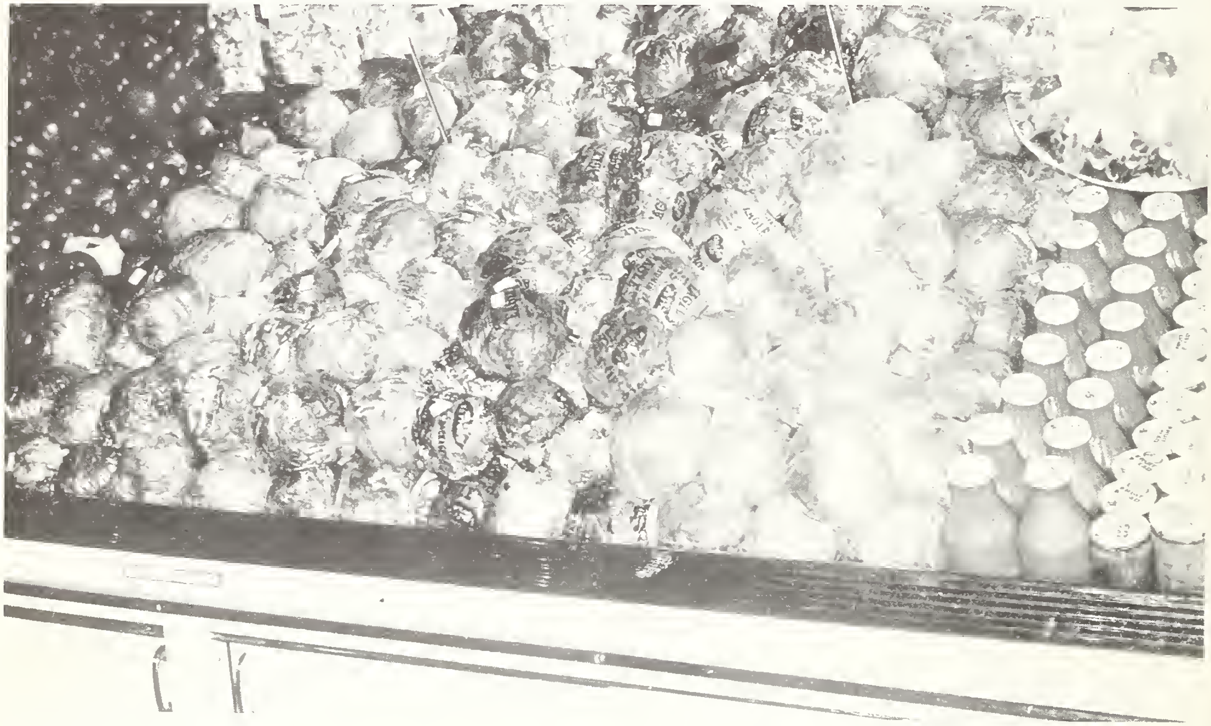
The earliest materials used for prepackaging lettuce in retail stores were cellophane bags and U-boards with overwraps of cellophane film. Cellophane has a slightly stiff feel to which consumers are generally accustomed. It feels similar in texture to crisp lettuce.

Nearly 10 years ago in another study 6/ it was found that unwrapped lettuce outsold lettuce prepackaged in cellophane bags more than 2 to 1 when a 1-cent a pound premium was charged for prepackaged lettuce. In more recent years, many retailers have prepackaged lettuce in less expensive polyethylene bags. Consumers have generally learned to accept the bags because they are handy for reuse in the kitchen after only a portion of the head is served. Over the years the consumers have become accustomed to the soft feel of the polyethylene.

6/ See footnote 2.

Wrapping lettuce in polystyrene film has been done very little in retail stores; hence, consumers are unaccustomed to the hard, brittle feel of the film which crackles when it is handled. Shoppers unfamiliar with hard film initially reacted unfavorably to polystyrene. Retail sales of test shipments of lettuce in polystyrene lagged behind sales of unwrapped lettuce and lettuce in two types of soft films but were about the same as sales of two other types of soft film wraps. However, consumers have not had enough opportunity to purchase lettuce wrapped in new films to form definite preferences.

Unwrapped lettuce and lettuce wrapped in five types of new film were examined in terminal markets and followed through to a cross section of large and small stores in three cities to observe salability and trade and consumer reaction (fig. 11). In New York, Philadelphia, and Chicago, sales of unwrapped lettuce were compared with sales of lettuce wrapped in polystyrene, cast polyvinyl chloride, extruded polyvinyl chloride, polyethylene, and polypropylene when displayed together for equal periods of time (table 5).



BN-19625

Figure 11.--Mixed displays of lettuce wrapped in a variety of films were set up in retail stores to determine relative salability.

Table 5.--Retail store sales of western Iceberg lettuce, unwrapped and wrapped in five types of films, 1961-62

City and date	Unwrapped	Type of film wrap				
		Poly-styrene	Cast PVC 1/	Extruded PVC	Poly-ethylene	Polypro-pylene
	Heads	Heads	Heads	Heads	Heads	Heads
New York:						
10-5-62	0	2	--	--	--	4
10-4-62	19	10	--	--	--	12
10-5-62	21	2	8	--	--	1
10-4-62	8	11	--	--	--	14
Philadelphia:						
2-10-62	--	20	--	78	64	--
2-10-62	--	45	--	104	106	--
11-28-61	--	22	20	30	--	--
11-29-61	53	12	8	9	--	--
11-28-61	--	22	20	30	--	--
10-23-61	12	16	--	--	--	--
10-19-61	10	5	--	--	--	--
10-6-61	48	30	--	--	--	--
9-29-61	132	72	--	--	--	--
9-30-61	147	75	--	--	--	--
Chicago:						
7-24-61	--	20	--	11	--	--

1/ PVC--polyvinyl chloride.

Comparative total sales and rate of sales of unwrapped lettuce and lettuce wrapped in the five types of film when displayed together in retail stores were as follows:

Time on display together, and type of wrap	Total sales	Sales per hour
	Heads	Heads
52 hours:		
Unwrapped	450	8.7
Polystyrene	235	4.5
13 hours:		
Unwrapped	74	5.7
Cast polyvinyl chloride	16	1.2
9 hours:		
Unwrapped	53	5.9
Extruded polyvinyl chloride	9	1.0

Continued

Continued

Time on display together, and type of wrap	Total sales	Sales per hour
	Heads	Heads
23 hours:		
Unwrapped	48	2.1
Polypropylene	31	1.3
31 hours:		
Polystyrene	58	1.9
Cast polyvinyl chloride	56	1.8
45 hours:		
Polystyrene	141	3.1
Extruded polyvinyl chloride	262	5.8
16 hours:		
Polystyrene	65	4.1
Polyethylene	170	10.6
23 hours:		
Polystyrene	25	1.1
Polypropylene	31	1.3
27 hours:		
Cast polyvinyl chloride	48	1.8
Extruded polyvinyl chloride	69	2.5
4 hours:		
Cast polyvinyl chloride	8	2.0
Polypropylene	1	0.2

The difference between unwrapped and polystyrene-wrapped heads were statistically significant; because of more limited observation, the other differences were not significant.

In addition to studying the sales of lettuce in mixed displays, researchers also observed more than 1,200 sales in five supermarkets--two in Boston and three in Grand Rapids--which introduced the polystyrene wraps to their customers in large, unmixed displays. Most of the shoppers picked up the prepackaged lettuce and dropped it in the cart with hardly a pause. A few turned it over, squeezed it, glanced about as if seeking another choice, then put it in the cart. Seldom was it returned to the display.

Although the most noticeable difference among the various films was the stiffness or softness of the feel of the film, there also were others. The same lettuce usually appeared darker and greener when wrapped in extruded polyvinyl chloride film than in polystyrene.

It is in the interest of the lettuce growers to promote maximum sales and consumption; therefore the type of packaging which will influence housewives to buy more lettuce is very important. Even though some consumers might prefer soft film, this factor must be weighed in relation to the effect of the film on maintaining the lettuce in the best condition over a suitable period of time.

In one store where lettuce in polystyrene was on sale, a housewife commented, "This is a good clear wrap but I cannot keep my unused lettuce in it. I will need another poly bag to keep it in." A male customer, in the same store, said, "It seems very hard and crinkly--sounds like dry leaves." Another woman shopper said, "This is a nice clear package--I like it."

This early consumer reaction to the stiff crinkly feel of polystyrene film was based on 1-1/4-mil film; later 1-mil film was generally used, and currently 0.85-mil appears to be equally serviceable. The 0.85-mil film, being thinner, does not feel as stiff.

In summary, consumers have mixed reactions to buying prepackaged lettuce; most prefer to buy freshly trimmed heads. However, they may not realize that 75 percent of vitamins are in the outer green leaves and that each time the lettuce is trimmed, its apparent freshness may be enhanced but the vitamin content is reduced.

ADVANTAGES

1. Reduces transport costs. This comes from the reduction in weight of 30 to 35 percent by removing the leaves at point of production instead of in the store.

2. Reduces bruising. By trimming and wrapping lettuce, it can be packed into shipping containers with no bulge and results in less pressure bruising.

3. Maintains condition longer. Films used to prepackage lettuce form a barrier that prevents excessive moisture loss and wilting.

4. Increases harvest volume of marketable lettuce under certain conditions. Some shippers reported that they had experienced higher yields of lettuce when they were prepackaging because they could sell trimmed and packaged heads which otherwise would have been unsalable because of injury to the outer leaves.

5. May lead to mechanization of harvesting and packaging operations. Widespread efforts to develop equipment to prepackage lettuce have led to increased interest in machines to harvest it.

6. Reduces labor requirements to prepare and maintain store displays.

7. Reduces waste and spoilage loss caused by shoppers handling displays.

8. Eliminates hazardous litter of broken leaves falling from displays into store aisles.

9. Provides shoppers with packages that are dry and easily handled.

DISADVANTAGES

1. Increases the cost of packaging materials and direct labor to pack by 30 to 43 cents a box, depending on the efficiency of the operation.

2. Requires more skilled labor to trim and wrap the heads. Field labor is becoming increasingly hard to get and, once trained, harder to keep.

3. Creates problem of what to do with "off-quality" lettuce in any harvested field. Buyers expect only the best quality in any prepackaged commodity, hence, inferior heads must be excluded from the wrapping operation.

4. Magnifies minor defects. The clear plastic wraps seem to bring every minor blemish into sharp focus. These defects, such as small discolored areas on ribs or margins, would not be objectionable in unwrapped lettuce from which they can be trimmed in the store.

5. Increases the shippers' losses in "trouble" cars. Shippers have a larger investment of material and labor in wrapped lettuce than in unwrapped lettuce. This increases their losses if a car of wrapped lettuce is rejected because of unsatisfactory condition on arrival. The wraps make it more difficult to salvage the rejected lettuce. Proponents of prepackaged lettuce reason that the total number of "trouble" cars will be reduced and that this will more than make up for the occasional car requiring salvage or price adjustment.

6. Results in brown, discolored butts. Many volume buyers, particularly independent wholesalers in terminal markets, discounted wrapped lettuce because the butts could not be trimmed without damaging the package. This reluctance to buy prepackaged lettuce diminished when it was learned that consumers were not greatly concerned by the color of the butt.

7. Sometimes encourages careless handling. The package seems to cause some retail clerks to forget that lettuce is a perishable product which should be rotated in the display with extreme care, whether wrapped or unwrapped.

8. Does not necessarily increase sales. Most observations indicated that when on sale together unwrapped lettuce outsold wrapped lettuce.

UNSOLVED PROBLEMS

Prepackaging lettuce at shipping point is still in the developmental stage. The California and Arizona lettuce industry ships approximately 100,000 carlot equivalents per year. About 6,000 carlot equivalents of wrapped lettuce were shipped in 1962. There are many reasons deterring rapid expansion of prepackaging lettuce at shipping point. Quality of lettuce varies. The supply of labor in various production areas is uncertain. The economic feasibility of setting up permanent prepackaging plants in short season production areas is questionable. Moving portable field packing sheds or mobile field packaging rigs from one production area to another is difficult. Some shippers are concerned over the possibility of lower net returns if prepackaging lettuce at shipping point becomes generally adopted and market prices do not adequately reflect their additional costs. Some lettuce shippers are striving to overcome these obstacles and to solve the various problems still confronting the wrapping of lettuce at shipping point.

Much work remains to be done in developing better shipping containers, improved carloading patterns, and more efficient machinery for field and shed operations. More efficient cooling and refrigeration practices need to be developed and put into effect.

Also essential to sound progress in the packaging of this perishable staple is more research to evaluate the ability of various films to maintain the quality of the lettuce wrapped in them. A recent report 7/ indicated the possibility of considerable damage to the outer leaves of lettuce wrapped in polystyrene from exposure to excessively high temperatures in the shrink tunnel. More experimentation to control the amount and direction of heated air in shrinking film around the lettuce is needed.

Consumer acceptance of various types of films needs more thorough study. Some retailers and produce merchandisers claim that consumers do not like a stiff and "crinkly" sounding film as well as a "soft" film. Data are not available to prove or disprove this statement.

Because varying numbers of wrapper leaves could be left on the heads in the unwrapped pack, it has not been necessary heretofore for the lettuce industry to adhere to strict sizing practices. Complaints have been expressed by buyers about the irregular sizes of heads found in the boxes of wrapped lettuce, indicating the need for more uniformity in sizing.

Although this most recent development program for packaging at shipping point has had some serious setbacks, many shippers have continued to experiment, develop, and perfect equipment and techniques that may bear fruit in several years. Because the retailers expect a degree of perfection in prepackaged lettuce that was not considered necessary in the conventionally packed unwrapped lettuce, the task is difficult and complex. The success of the program ultimately depends on the packaging of lettuce of initially good quality; strict control over trimming, packaging and sizing; and rapid precooling and maintenance of low temperatures in distribution channels.

7/ Ceponis, M. J., and Griffin, G. J. "Effect on Heat-Tunnel Temperatures of Shrink-Film-Wrapped Lettuce" U. S. Dept. Agr. Mktg. Res. Rpt. 634, 1963.

APPENDIX

Table 6.--Arrival condition of western Iceberg lettuce prepackaged in 1-mil polystyrene film, and nonwrapped lettuce, 1 truck and 9 rail shipments, 1961

Type of pack and date shipped	In transit	Ribs bruised and discolored				Leaves bruised and discolored				Decay	Perfect heads	Salable heads	Non-salable heads
		Very slight	Slight	Damage	Serious	Very slight	Slight	Damage	Serious				
Nonwrapped	Days	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
6/28/61	7	25.0	25.0	0	0	4.2	4.2	0	0	0	1/75.0	10.0	0
9/21/61	7	31.0	21.4	7.1	0	9.5	2.4	0	0	4.8	23.8	88.1	11.9
9/22/61	7	22.9	4.2	2.1	0	18.7	2.1	0	0	2.1	47.9	95.8	4.2
9/27/61 2/	5	25.0	36.4	0	0	16.7	22.2	0	0	0	0	100	0
9/28/61	7	33.3	4.2	0	0	16.7	0	0	0	0	45.8	100	0
10/ 4/61	7	38.6	10.4	0	0	18.7	6.2	0	0	4.2	22.9	95.8	4.2
10/ 5/61	8	45.8	12.5	0	0	14.6	0	0	0	4.2	22.9	95.8	4.2
10/12/61	6	25.0	2.8	0	0	19.4	2.8	0	0	2.8	47.2	97.2	2.8
10/13/61	6	20.8	8.3	6.2	0	25.0	10.4	6.2	0	6.2	16.7	81.2	18.8
11/ 1/61	7	8.3	39.6	0	0	0	16.7	6.2	0	6.2	22.9	93.8	6.2
Average	6.7	27.8	15.7	1.6	0	14.8	6.6	1.4	0	3.3	30.8	94.4	5.6
Wrapped													
6/28/61	7	16.7	0	0	0	0	0	0	0	0	83.3	100	0
9/21/61	7	27.4	0	0	0	15.5	0	0	0	0	57.1	100	0
9/22/61	7	33.3	3.3	0	0	24.4	0	0	0	0	38.9	100	0
9/27/61 2/	5	11.5	14.1	0	0	2.6	0	0	0	1.3	3/12.8	98.7	1.3
9/28/61	7	28.6	1.6	0	0	19.0	0.8	0	0	0	50.0	100	0
10/ 4/61	7	49.1	6.5	0	0	13.0	2.8	0	0	1.9	26.9	98.1	1.9
10/ 5/61	8	35.2	31.5	1.9	0	11.1	0	0	0	1.9	18.5	96.3	3.7
10/12/61	6	51.9	11.1	0	0	0	0	0	0	0	37.0	100	0
10/13/61	6	23.6	2.8	0	0	9.7	1.4	0	0	0	62.5	100	0
11/ 1/61	7	3.4	21.6	4.3	0.9	8.6	14.7	2.6	0	0	44.0	97.4	2.6
Average	6.7	27.7	9.1	0.7	0.1	12.2	2.7	0.4	0	0.5	41.1	99.0	1.0

1/ Because the defects were so minor, some of the heads listed in this shipment as "very slightly bruised and discolored" also were classified as perfect.

2/ Truck shipment.

3/ Perfect heads usually were considered to be all those in the selected sample not having a listed defect. However, in addition to listed defects, a large number of wrapped heads in this shipment also showed russeting.

Table 7.--Condition of western Iceberg lettuce, nonwrapped and prepackaged in 2 film wraps on arrival at Philadelphia, Pa., and after holding 1 to 5 days at specified temperatures, October 1961

Type of packaging, and holding period and temperature	Sample	Time after shipment	Ribs bruised and discolored			Leaf bruised and discolored			Decay	Perfect	Salable	Nonsalable
			Very slight	Slight	Damage	Very slight	Slight	Damage				
	Heads	Days	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Nonpackaged												
On arrival (39° F.)	36	6	25.0	2.8	0	19.4	2.8	0	2.8	47.2	97.2	2.8
Carton 1, held--												
1 day at 67°	18	7	16.7	22.2	5.6	16.7	16.7	0	5.6	16.7	88.9	11.1
2 days at 67°	18	8	11.1	11.1	22.2	11.1	11.1	27.8	5.6	0	44.4	55.6
5 days at 67°	18	11	0	0	0	0	0	0	100.0	0	0	100.0
Carton 2, held--												
1 day at 43°	18	7	16.7	11.1	0	16.7	5.6	0	5.6	44.4	94.4	5.6
2 days at 43°	18	8	16.7	11.1	0	16.7	5.6	0	5.6	44.4	94.4	5.6
5 days at 43°	18	11	27.8	27.8	0	11.1	16.7	0	5.6	11.1	94.4	5.6
Polystyrene, 1-mil												
On arrival (39° F.)	54	6	51.9	11.1	0	0	0	0	0	37.0	100.0	0
Carton 1, held--												
1 day at 43° and 1 day at 67°	18	8	55.6	16.7	0	0	0	0	5.6	22.2	94.4	5.6
1 day at 43° and 2 days at 67°	18	11	38.9	5.6	0	11.1	5.6	0	16.7	22.2	83.3	16.7
Carton 2, held--												
2 days at 67°	18	8	44.4	5.6	16.7	0	11.1	0	5.6	16.7	77.8	22.2
5 days at 67°	18	11	0	0	11.1	16.7	5.6	16.7	50.0	0	22.2	77.8
Carton 3, held--												
2 days at 43°	18	8	50.0	22.2	0	0	16.7	0	0	11.1	100.0	0
5 days at 43°	18	11	38.9	33.3	16.7	0	16.7	0	0	11.1	83.3	16.7
PVC, extruded, 0.75-mil												
On arrival (39° F.)	52	6	50.0	13.5	0	1.9	0	0	0	34.6	100.0	0
Carton 1, held--												
1 day at 43° and 1 day at 67°	18	8	55.6	16.7	16.7	0	0	0	0	11.1	83.3	16.7
1 day at 43° and 2 days at 67°	18	11	0	22.2	27.8	0	16.7	11.1	22.2	0	38.9	61.1
Carton 2, held--												
2 days at 67°	16	8	37.5	12.5	18.8	12.5	0	0	0	18.8	81.2	18.8
5 days at 67°	16	11	0	6.2	18.8	0	6.2	12.5	56.2	0	12.5	87.5
Carton 3, held--												
2 days at 43°	18	8	50.0	22.2	0	11.1	5.6	0	0	11.1	100.0	0
5 days at 43°	18	11	27.8	27.8	0	11.1	16.7	0	5.6	11.1	94.4	5.6

Table 8.--Condition of western Iceberg lettuce, nonwrapped and prepackaged in 2 film wraps on arrival in terminal markets and after holding 1 to 3 days at specified temperatures, Philadelphia, Pa., October 1961

Type of packaging, and holding period and temperature	Sample	Time after shipment	Ribs bruised and discolored			Leaves bruised and discolored			Decay	Perfect	Salable	Nonsalable
			Very slight	Slight	Damage	Very slight	Slight	Damage				
	Heads	Days	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Nonpackaged												
On arrival (41° F.)....	48	6	20.8	8.3	6.2	25.0	10.4	6.2	6.2	16.7	81.2	18.8
Carton 1, held--												
1 day at 43°.........	24	7	16.7	16.7	16.7	25.0	8.3	8.3	0	8.3	75.0	25.0
3 days at 43°........	24	9	0	8.3	4.2	8.3	16.7	16.7	41.7	4.2	37.5	62.5
Carton 2, held--												
1 day at 67°.........	24	7	16.7	8.3	8.3	12.5	8.3	20.8	12.5	12.5	58.3	41.7
3 days at 67°........	24	9	0	0	8.3	8.3	16.7	33.3	33.3	0	25.0	75.0
Polystyrene, 1-mil												
On arrival (40° F.)....	72	6	23.6	2.8	0	9.7	1.4	0	0	62.5	100.0	0
Carton 1, held--												
1 day at 67°.........	24	7	20.8	4.2	0	16.7	12.5	0	4.2	41.7	95.8	4.2
3 days at 67°........	24	9	4.2	8.3	4.2	12.5	12.5	12.5	45.8	0	37.5	62.5
Carton 2, held--												
1 day at 43°.........	24	7	33.3	8.3	0	8.3	8.3	0	0	41.7	100.0	0
3 days at 43°........	24	9	33.3	8.3	0	8.3	8.3	0	0	41.7	100.0	0
Carton 3, held--												
1 day at 43°.........	24	7	29.2	4.2	0	4.2	0	0	0	62.5	100.0	0
1 day at 43° and 2 days at 67°......	24	9	8.3	4.2	0	37.5	12.5	4.2	4.2	29.2	91.7	8.3
PVC, extruded, 0.75-mil												
On arrival (41° F.)....	72	6	38.9	11.1	4.2	11.1	1.4	0	0	33.3	95.8	4.2
Carton 1, held--												
1 day at 67°.........	24	7	41.7	12.5	4.2	16.7	4.2	0	0	20.8	95.8	4.2
3 days at 67°........	24	9	0	8.3	4.2	8.3	16.7	16.7	41.7	4.2	37.5	62.5
Carton 2, held--												
1 day at 43°.........	24	7	45.8	20.8	12.5	0	0	0	0	20.8	87.5	12.5
1 day at 43° and 2 days at 67°......	24	9	8.3	8.3	12.5	12.5	20.8	4.2	33.3	0	50.0	50.0
Carton 3, held--												
1 day at 43°.........	24	7	41.7	12.5	8.3	4.2	8.3	0	0	25.0	91.7	8.3
3 days at 43°........	24	9	29.2	33.3	8.3	4.2	12.5	0	4.2	8.3	87.5	12.5

Table 9.--Condition of western Iceberg lettuce, prepackaged in 3 film wraps on arrival at terminal market and after holding 1 to 3 days at 65° F., Philadelphia, Pa., November 1961

Days held, temperature, and type of film wrap 1/	Days from shipment	Ribs bruised and discolored		Leaves bruised and discolored		Decay	Perfect	Salable	Nonsalable
		Very slight	Slight	Very slight	Slight				
	No.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Arrival at 38° F.									
1-mil polystyrene	6	5.3	0	5.3	0	0	89.5	100.0	0
0.5-mil polyvinyl chloride 2/	6	10.5	0	21.1	0	0	68.4	100.0	0
0.75-mil polyvinyl chloride	6	15.0	0	15.0	0	0	70.0	100.0	0
1 day at 65° F.									
1-mil polystyrene	7	5.3	0	5.3	0	0	89.5	100.0	0
0.5-mil polyvinyl chloride	7	15.8	0	21.1	0	0	63.2	100.0	0
0.75-mil polyvinyl chloride	7	15.0	0	15.0	0	0	70.0	100.0	0
2 days at 65° F.									
1-mil polystyrene	8	15.8	0	10.5	0	0	73.7	100.0	0
0.5-mil polyvinyl chloride	8	26.3	5.3	15.8	5.3	0	47.4	100.0	0
0.75-mil polyvinyl chloride	8	15.0	10.0	10.0	0	0	65.0	100.0	0
3 days at 65° F.									
1-mil polystyrene	9	10.5	5.3	10.5	0	5.3	68.4	94.7	5.3
0.5-mil polyvinyl chloride	9	26.3	5.3	15.8	10.5	0	42.1	100.0	0
0.75-mil polyvinyl chloride	9	15.0	15.0	10.0	0	5.0	55.0	95.0	5.0

1/ 1-mil polystyrene film was unperforated; 0.5-mil cast polyvinyl chloride and 0.75-mil extruded polyvinyl chloride were perforated.

2/ Film wraps were torn on more than 25 percent of heads examined.

Table 10.--Condition of western Iceberg lettuce prepackaged in 5 film wraps after 9 days in transit and 5 days' holding, average of 4 test shipments, New York City, October 1962 1/

Type of wrap	Decay				Tipburn				Russet spotting				Salable	Non-salable
	Trace	Slight	Moderate	Severe	Trace	Slight	Moderate	Severe	Trace	Slight	Moderate	Severe		
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
0.5-mil cast PVC, perforated, shrunk 2/	14.3	30.0	22.9	8.6	1.4	1.4	1.4	0	10.0	8.6	5.7	1.4	44.3	55.7
0.75-mil extruded PVC, perforated, not shrunk 2/	18.6	21.4	11.4	11.4	2.9	5.7	2.9	1.4	8.6	10.0	1.4	7.1	72.9	27.1
0.5-mil polypropylene, perforated, not shrunk	8.6	20.0	14.3	8.6	7.1	10.0	5.7	4.3	10.0	12.9+	5.7	2.9	64.3	35.7
0.6-mil polyethylene bags: perforated	14.3	18.6	11.4	1.4	4.3	10.0	7.1+	0	11.4	7.1	2.9	1.4	71.4	28.6
0.85-mil polystyrene, nonperforated, shrunk	24.3	21.4	11.4	1.4	2.9	5.7+	0	0	10.0+	10.0+	4.3+	1.4	68.6	31.4
Not wrapped	11.4	8.6	17.1	5.7	11.4	5.7	1.4	0	8.6	15.7	2.9	1.4	62.9	37.1

1/ In each of 3 shipments, 18 heads of nonwrapped lettuce and 18 heads wrapped in each specified film were held 4 days at 44° F. plus 1 day at 70° F. in the Market Quality Research Laboratory; in one shipment, 16 heads were held, making a total sample of 70 heads from each treatment.

2/ PVC is the alphabetic designation commonly used for polyvinyl chloride.

U. S. DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service
Washington, D. C. 20250

- - -

Official Business

Postage and Fees Paid
U. S. Department of Agriculture

3/ 2
3840

UNITED STATES DEPARTMENT OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
U.S. DEPARTMENT OF AGRICULTURE

U.S. DEPARTMENT OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY

NATIONAL AGRICULTURAL LIBRARY
1022726297